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OPERATING AND SERVICE MANUAL 602A NOISE GENERATOR INCLUDING 602A-1390

Serial Numbers Prefixed 026-

FEDERAL STOCK NUMBER
2Z6625-888-5547
APPLIES TO MODEL 602A-1390

ELGENCO INCORPORATED
1550 EUCLID STREET • SANTA MONICA, CALIFORNIA 90404 • (213) 451-1635

ELGENCO INCORPORATED
1231 COLORADO AVENUE • SANTA MONICA, CALIFORNIA • EXBROOK 3-3023

IMPORTANT

Immediately upon receipt the instrument should be thoroughly inspected for possible damage in shipment. If the instrument is damaged in any way, a claim should be filed with the carrier. All material in the container should be checked against the enclosed packing list. The seller will not be responsible for shortages against the packing list unless notified immediately.

WARRANTY

Elgenco, Incorporated warrants each instrument manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to making good at the factory any part or parts thereof except electron tubes, fuses, electro-mechanical choppers and batteries. This warranty is effective for one year after delivery to the original purchaser: when the instrument is returned, transportation charges prepaid by the original purchaser; and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operations, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

RESERVED RIGHTS

Elgenco, Incorporated reserves the right to discontinue instruments without notice, to make changes in design, and to make additions or improvements at any time without incurring any obligation to make such modifications to instruments previously manufactured.

It is the policy of Elgenco, Incorporated to supply equipment patterned as closely as possible to the particular requirements of the individual customer. As much as possible this is accomplished, without incurring the costs of custom design, by substituting new components, modifying old components, etc. As a result, this instruction manual, which has basically been written to cover standard equipment, may not entirely concur in its content with the equipment supplied. It is felt, however, that a technically qualified person will find the manual a fully adequate guide in understanding, operating, and maintaining the equipment actually supplied.

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SECTION 1

INTRODUCTION

This manual is intended for use in the operation and maintenance of the Elgenco Model 602A Gaussian Noise Generator.

The Model 602A Noise Generator is a self-contained precision device designed for use where reliable sources of random noise are needed. The noise generator provides an output having a Gaussian (normal) distribution with negligible mean (dc unbalance). Three frequency ranges are provided; each from 5 cycles per second to an upper frequency of from 20 kilocycles per second to 5 megacycles per second. Within each frequency range the power spectrum is uniform.

This instrument has been thoroughly checked and tested before shipment from the factory and is ready for use when received. Upon receipt of the instrument, inspect carefully for any damage which may have been incurred in transit.

The Model 602A is identified by a five-digit serial number with a three-digit prefix (000-00000). The prefix appears on the title page of this manual and indicates to which instrument the manual directly applies. A supplement may be included with this manual to indicate the necessary changes to be made in the manual to make it apply directly to Models 602A which carry a different serial number prefix.

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SECTION 2

SPECIFICATIONS

SPECTRAL CHARACTERISTICS

Three ranges: 5 Hz to 20 kHz, 5 Hz to 500 kHz, and 5 Hz to 5 mHz.

Range	Spectrum Uniformity			Approximate Spectral Density, mv/$\sqrt{\text{Hz}}$ for 1 volt RMS Output	
		602A	602A-1390	602A	602A-1390
20 kHz	20 Hz to 20 kHz	±1.0db	±1db	5	5
500 kHz	20 Hz to 500 kHz	±2.5db	±3db	1.2	1.2
5 mHz	20 Hz to 500 kHz	±2.5db	±3db	0.4	0.6
	500 kHz to 5 mHz	±6.0db	±8db		

The output is down approximately 3 db at 5 Hz on all bands.

OUTPUT LEVEL

(Minimum value of maximum open circuit output)

Range	602A	602A-1390
200 kHz	3 volts rms	3 volts rms
500 kHz	2.5 volts rms	2 volts rms
5 mHz	2 volts rms	1 volt rms

A dynamic range of 3.5 to 1 peak to rms value is provided at 3 volts open circuit output; greater at lower output amplitude control settings.

OUTPUT STEP ATTENUATOR

Five positions: X1.0, X0.1, X.01, X.001, and X.0001; calibrated to work into open circuit.

Accuracy ±3% to 100 kHz
±10% to 5 mHz

Output Impedance 200 ohms ±1%

AMPLITUDE PROBABILITY DISTRIBUTION

Symmetrical Gaussian distribution on all ranges.

OUTPUT METER

Rectifier type meter circuit reads proportional to average value, calibrated to read rms value of Gaussian Noise; 0-5 volts rms scale.

OUTPUT IMPEDANCE

(On direct output)

900 ohms ±10%

MAXIMUM LOAD
(on direct output)

No limit

POWER REQUIREMENTS

115/230 volts ±10/20 volts, 50 to 1000 cps, approximately 5 watts. The Model 602A with battery option provides 10 hours of operation on the battery. Battery is recharged by operating the unit on the AC line, with approximately 30 hours required for complete recharge.

DIMENSIONS

5-1/4" high x 8-5/8" wide x 11" deep.

WEIGHT

Net without battery option 9.5 lbs.
Net with battery option 12 lbs.
Shipping without battery approximately 11 lbs.

RACK MOUNT

A rack mounting adapter kit is available for rack mounting one unit. Also available is a kit for rack mounting two units side by side. One or two units use 5-1/4" x 19" of rack panel space with the adapter kit.

SECTION 3

CONTROLS & INDICATORS

FRONT PANEL

AMPLITUDE potentiometer and meter. The potentiometer is used to vary the rms value of the output. The meter indicates the rms value prior to the attenuation by the ATTENUATOR switch.

ATTENUATOR - five position switch. This switch allows attenuation of output. Steps are X1.0, X0.1, X0.01, X0.001, X0.0001.

RANGE - three-position switch. This switch allows selection of frequency range of output.

LINE - switch and light. The switch applies line power to the unit and to the light. In the case of the battery operated instrument, the switch also applies DC power to the unit.

REAR PANEL

115/230 - switch. Allows operation on either of two line voltages.

AC - connector and slo-blo fuse. Connector is provided for 115/230 VAC input power. The fuse is on the ac line.

PRINTED CIRCUIT BOARDS.

AMPLIFIER ASSEMBLY

Two potentiometers (one on potted assy. A1A1) allow factory adjustment of the noise source and amplifier gain.

METER ASSEMBLY

One potentiometer allows adjustment of the meter rectifier circuit.

POWER SUPPLY ASSEMBLY

A potentiometer allows adjustment of the -30V power supply.

OPERATION

ORIENTATION

SECTION 4

INSTALLATION & OPERATION

INSTALLATION

Place the switch on the rear panel to the proper position (115V or 230V) and check for installation of the proper fuse. Connect the power cord to the power source and place the LINE switch to its ON position. The LINE light should light immediately. (The LINE light does not operate when battery power is used.) Within a few seconds the meter should provide an upscale reading. Allow a few minutes settling time.

Operate the RANGE switch to 20 kc. Adjust the AMPLITUDE potentiometer to give a 1.0-volt rms reading on the meter. Operate the RANGE switch through the remaining two positions, adjusting the AMPLITUDE potentiometer at each position for a 1.0-volt rms reading on the meter.

OPERATION

To attenuate the noise generator output, the AMPLITUDE potentiometer should be used to provide continuous control between 1 volt and maximum output. For output levels below 1 volt, the ATTENUATOR is provided to allow attenuation in 20 db increments.

The OUTPUT meter indicates the rms voltage applied to the output ATTENUATOR; therefore the actual output level is the voltage indicated on the meter multiplied by the ATTENUATOR setting, neglecting loading considerations.

In the X1 ATTENUATOR setting the attenuator is disconnected and the noise generator output is applied directly to the load.

The lower four ATTENUATOR positions are calibrated for infinite load resistance. For high values of load resistance the error is negligible; for low values of load resistance, or where very high accuracy is required, the load voltage (E_L) at a resistive load (R in ohms) may be calculated from the indicated voltage (E_I) as follows:

$$E_L = E_I \times \frac{R}{R + 200}$$

Use of the 5MC range requires proper attention to the effect of shunt capacity at the load.

The battery operated instrument will provide approximately 10 hours of operation on the fully charged battery. The battery is recharged by operating the instrument on AC power, with approximately 30 hours required for a full recharge.

CAUTION

Do not charge the battery for extended periods of time (more than approximately four hours) at ambient temperatures above 50°C or 122°F.

SECTION 5

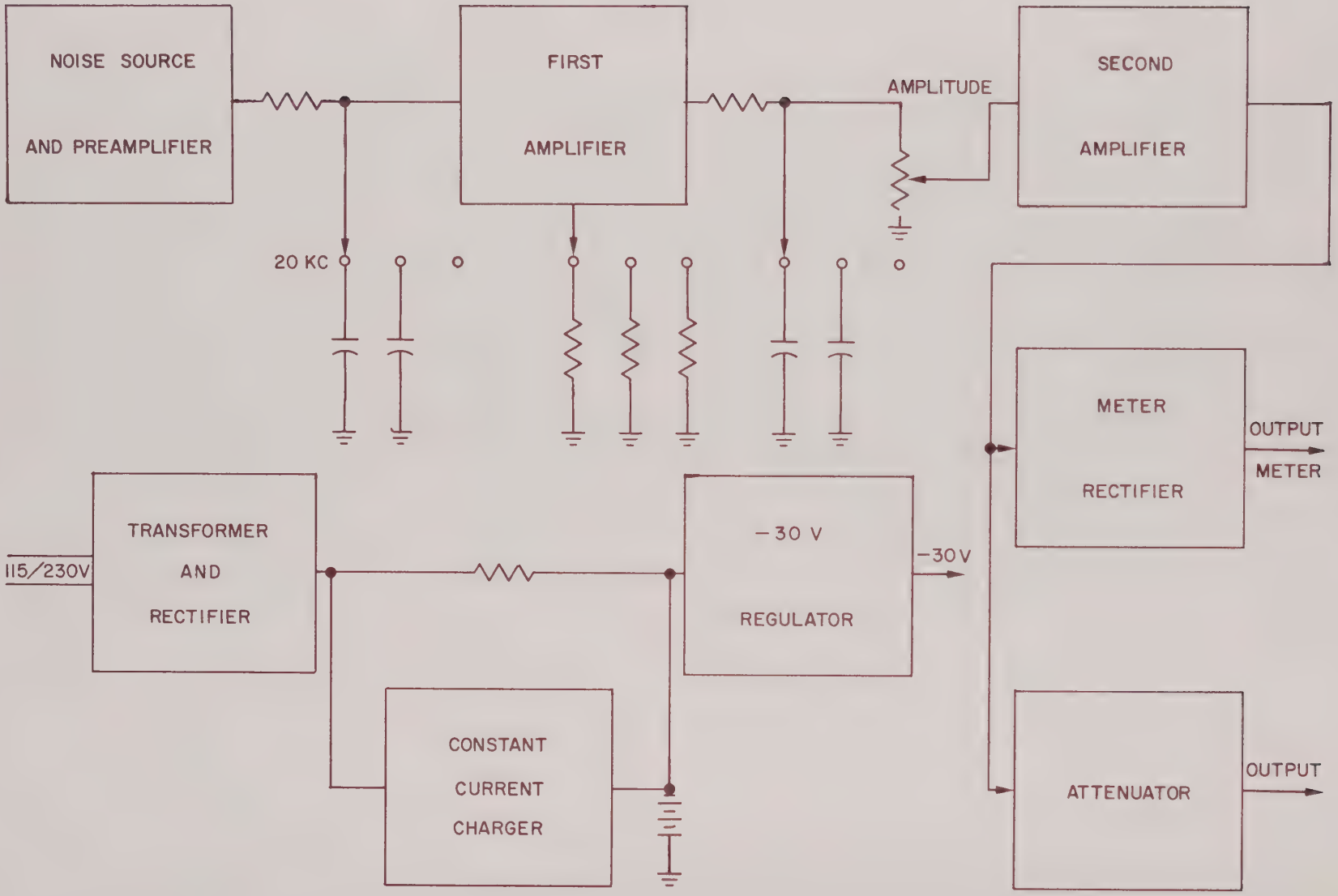
THEORY OF OPERATION

GENERAL

A block diagram of the Model 602A Noise Generator is given in Figure 5-1. The Model 602A Noise Generator employs a solid state device as a noise source. The output of the noise source is amplified by a special low noise feedback preamplifier. The noise is then passed through a switchable single pole low pass RC filter. The resulting signal is then further amplified by a variable gain feedback amplifier. The appropriate gain for each frequency range is selected by the range switch. The resulting noise voltage is then passed through another switchable single pole low pass RC filter and through the amplitude control to the output amplifier. The output of this amplifier is fed to the output meter and five position output attenuator. The output of the attenuator is brought to the front panel. The output meter is an average reading voltmeter calibrated to read the rms value of a Gaussian distributed voltage. The required dc power is supplied by a regulated power supply that uses a zener reference diode.

A1A1 NOISE SOURCE AND PREAMPLIFIER

This unit is encapsulated to achieve high component density and predictable frequency and temperature characteristics. A potentiometer allows factory adjustment of the noise source for optimum characteristics. Another potentiometer, which is mounted on the printed circuit board, allows factory adjustment of the preamplifier gain. The high gain preamplifier uses negative feedback to achieve good dc stability. The unit is mounted with decoupling networks R1-C1 and R2-C2 on the AMPLIFIER ASSEMBLY printed circuit board. R6 and the capacitors mounted at terminals 4 and 5 of RANGE switch A1S1, comprise the first filter section.


NOISE SOURCE
AND PREAMPLIFIER
FIRST
AMPLIFIER
AMPLITUDE
SECOND
AMPLIFIER
20 KC
METER
RECTIFIER
OUTPUT
METER
TRANSFORMER
AND
RECTIFIER
115/230V
−30 V
REGULATOR
−30V
CONSTANT
CURRENT
CHARGER
ATTENUATOR
OUTPUT

FIRST AMPLIFIER

Transistors Q1 and Q2 function as a feedback amplifier. Negative feedback is accomplished through the action of R12 and the resistor (R13, R14, R15) selected by the RANGE switch. The gain is approximately 750, 175, and 75 for 20 kc, 500 kc, and 5 mc, respectively. These gain levels, in conjunction with the gain levels provided by the first amplifier, allow for the proper output spectral density levels while maintaining the proper rms output for each band.

A high degree of dc stability is maintained through the action of emitter resistors R10, R11, and the feedback action of R12 and associated resistors on the RANGE switch. The output of this amplifier is applied through coupling capacitor C8 to the second RC filter section, R16 and associated capacitors on the RANGE switch, and then to the front panel AMPLITUDE control.

SECOND AMPLIFIER

Transistors Q3 and Q4 and associated circuitry comprise a feedback amplifier. Within the passband this amplifier provides a gain of ten, fixed by the feedback operation of R20 and R21.

Series resistor R24 raises the output impedance (at OUTPUT terminals) to approximately 900 ohms.

METERING

The meter rectifier circuit is arranged in a bridge-type configuration with a diode, CR1 or CR2, and a capacitor, C2 or C3, in each branch and a dc microammeter connected across the branch midpoints. The current through the meter is proportional to the average value of the input voltage. The meter, through the use of R2 and C1, is factory calibrated to indicate the rms value of the noise generator output.

POWER SUPPLY

The power supply utilizes a standard series regulator circuit. Rectified,

filtered DC is applied to the series regulating transistor A4Q5. Two differential amplifier stages regulate the operation of Q5. A change in output voltage is sensed by Q1-Q4 and the amplified push-pull error drives Q2-Q3. The single ended output from Q3-C controls series regulator Q5. R2 is adjusted to provide -30V DC at the output.
The Model 602A may be ordered with a rechargeable nickel-cadmium battery, or this feature may be added at any later time. In either case, BT1 supplies -36V DC to A3Q5C through A4CR4 on constant current CHARGER ASSEMBLY whenever LINE switch is turned ON with no AC power applied to J1. When AC power is applied to J1 (and LINE switch is ON), A4CR4 is back biased, and the battery is recharged by a constant current of approximately 20 ma through A4CR5. A fully charged battery will provide approximately 10 hours operation. Complete recharge requires approximately 30 hours.

CAUTION

Do not charge the battery for extended periods of time (more than approximately four hours) at ambient temperatures above 50 degrees C or 122 degrees F.

MAINTENANCE

SECTION 6

MAINTENANCE

GENERAL

The maintenance data provided in this section assumes that maintenance personnel are familiar with the operating procedures and theory given in sections 4 and 5.

The Model 602A Noise Generator is designed for long component life. The output stage has been designed to protect circuit elements against possible output short circuiting. Transistors, being inherently long life devices, should not require replacement. If it becomes apparent, through systematic trouble shooting, that replacement is necessary, care should be taken not to damage the associated printed circuit board. Transistors can be damaged by excessive heat.

If it is determined that a component requires replacement, a component of the same quality, or of better quality, must be used in the replacement process.

When servicing the printed circuit boards; do not apply excessive heat to the conductor or component being soldered; clean all holes before inserting new components; remove components whit a straight upward motion; and solder from the conductor side.

As a guide in troubleshooting, typical voltages to circuit ground, are included in table 6-1.

Photographs of the unit subassemblies are shown at the end of this section starting with Figure 6-1.

CHASSIS DISASSEMBLY

The Model 602A is opened for servicing by removing either of the two side covers, sliding out the top and bottom covers, and sliding out the remaining side cover and attached rods.

A1 AMPLIFIER ASSEMBLY is exposed by removing the shield on the left side of the unit.

After removing either of the side shields, reinstall the flat head screws, and thus secure the interior assemblies to the front and rear panels before applying power to the unit.

CAUTION

When reassembling the instrument do not tighten the 8 flat head screws (4 each in top and bottom) before first assembling and tightening the two side castings in place on the instrument without the painted top and bottom covers. In this manner the internal sheet metal fixes the proper spacing between front and rear panels. One of the side castings may then be removed, top and bottom covers slid into place and side replaced.

TEST EQUIPMENT

The following test equipment, or equipment comparable in scope, is required for complete testing of the Model 602A.

(1) 15 mc oscilloscope. (Tektronix 531A)

(2) True rms voltmeter with a crest to rms factor of at least 8 to 1 and 10 mc bandwidth. (Hewlett-Packard 3400A).

(3) Spectrum analysis equipment to cover 10 cps to 10 mc (Hewlett-Packard 302A - 7 cps bandwidth, 10 cps to 50 kc, 30 microvolt sensitivity, modified to provide at least one-minute meter time constant.

Hewlett-Packard 310A - 200 cps, 1000 cps, or 3000 cps bandwidth, 1 kc to 1.5 mc, 10 microvolt sensitivity, modified to provide 20-second meter time constant.

Rhode and Schwarz Type USVH BN1521 Selective Microvoltmeter - 500 cps or 5 kcps bandwidth, 100 kc to 30 mc.)

(4) DC vacuum tube voltmeter.

POWER SUPPLY ADJUSTMENT

The -30 volt power supply output is adjusted to -30 volts ±0.25 volts to insure proper operation of the 602A. The rms noise level on this supply should be less than 3 millivolts on the 2 kc range.

After replacement of any component in the power supply, check the following:

(1) Output is -30V ±0.25v (adjust A3R2).

(2) Power supply regulates over entire range of input AC voltage.

(3) Noise level is below 3 millivolts on the 2 kc range.

METER CIRCUIT

If the need arises to test the metering circuit, it should be tested with the printed circuit board mounted on the meter. Any adjustment of A2R2 must be made with the meter and circuit board properly mounted on the front panel.

NOTE:

The meter circuit is calibrated to indicate the rms value of Gaussian noise. Gaussian noise will provide inaccurate readings when applied to average or peak responding voltmeters calibrated to indicate the rms value of sinusoidal waveforms; therefore, only a true rms voltmeter should be used as a calibrator.

Adjust A2R2 at 2V on the 20 kc range.

Check three places on each of the three ranges and reajust A2R2 as required.

A1 AMPLIFIER ASSEMBLY TROUBLESHOOTING

The adjustment on encapsulated assembly A1A1 should not be disturbed under any circumstances, and the variable resistor on the circuit board need only be adjusted in case of the replacement of A1A1. In such a case, the initial adjustment position should be clearly marked and noted,

and adjustment should be made to provide the proper output voltage (3V rms on 20 kc range).

Because of the high gain in the noise generator, systematic checking of the gain-frequency response characteristics from noise source to the output is not advised.

Noise generator operation may be tested by observing:

(1) That the proper voltage output is obtained at each setting of the RANGE switch.

(2) That the spectral density is uniform within specified limits within each band.

When equipment is used to determine spectral density, care should be exercised to insure that length of measurement is consistent with bandwidth of measurement (i.e. several minutes measurement time is required on the lower range).

Malfunctions may be isolated according to whether they affect all bands or one band. In case all bands are affected, a check of the DC levels will usually indicate the problem area. One bad band only indicates a faulty switch or filter component. It should be noted that grossly in-error power spectral density uniformities will also be observed as improper output levels.

TABLE 6-1 TYPICAL VOLTAGE TO GROUND

	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	E	B	C
A1A1	18.5	11.9	1.6	0.2	0			
A1Q1						8.3	8.9	11.8
A1Q2						12.4	11.8	4.3
A1Q3						1.7	2.4	29.5
A1Q4						30.0	29.5	15.6
A3Q1						5.1	5.3	15.8
A3Q2						15.7	15.8	30.0
A3Q3						15.7	15.8	30.2
A3Q4						5.1	5.2	15.8
A3Q5						30.0	30.2	38.7

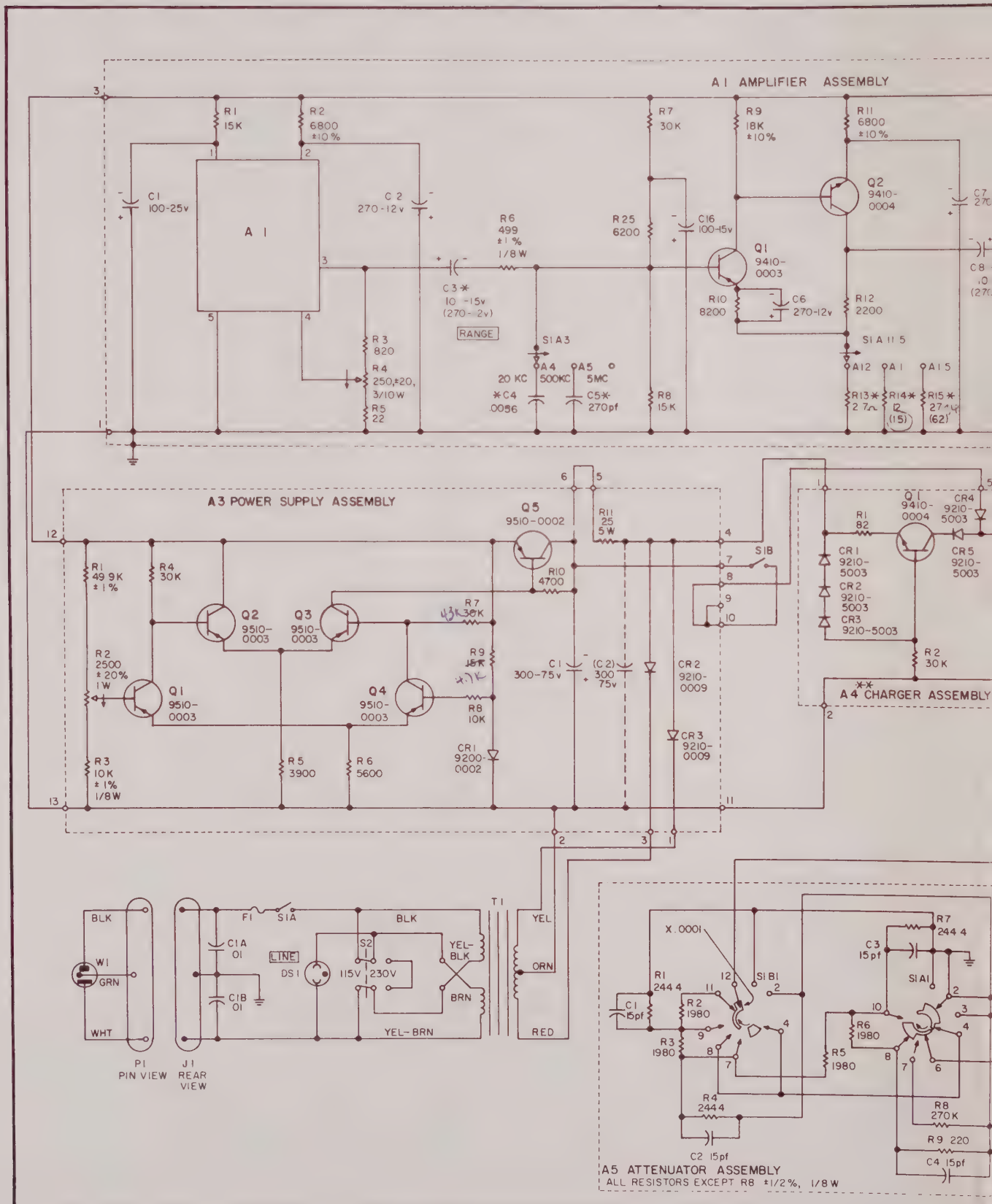
All voltages are negative and measured to ground with an HP 412A VTVM.

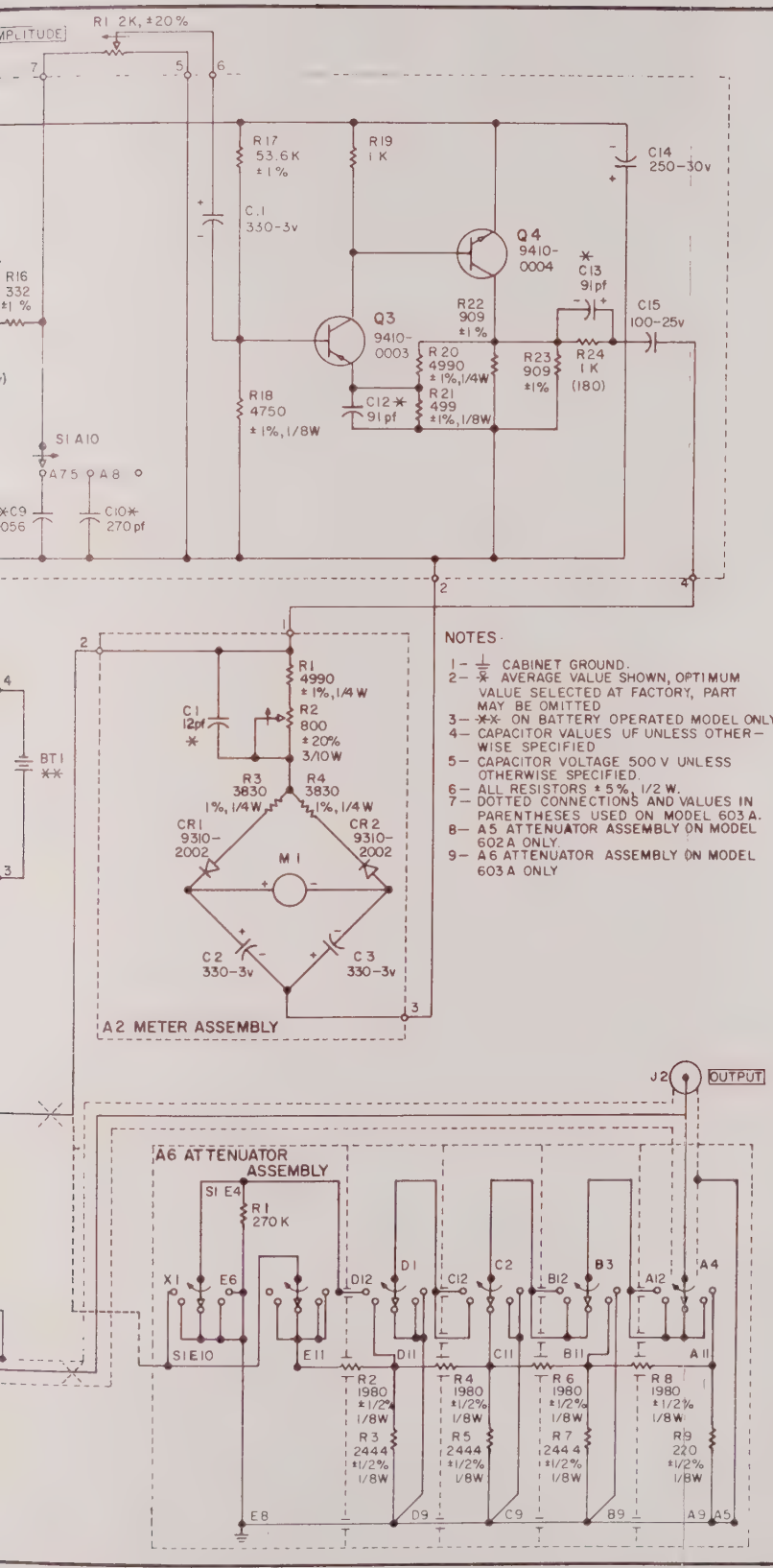
AMPLITUDE at full CCW.

RANGE at 20 kc.

115 VAC input.

No battery installed.


A1 AMPLIFIER ASSEMBLY
A1
C1 100-25v
C2 270-12v
R1 15K
R2 6800 ±10%
R3 820
R4 250,±20, 3/10W
R5 22
R6 499 ±1% 1/8W
C3* 10 -15v (270--2v)
RANGE
S1A3
A4 20 KC
A5 500KC
A6 5MC
*C4 .0056
C5* 270pf
R7 30K
R8 15K
R25 6200
C16 100-15v
Q1 9410-0003
R9 18K ±10%
R10 8200
C6 270-12v
R11 6800 ±10%
Q2 9410-0004
R12 2200
S1A11 5
A12
A11
A15
R13* 2.7Ω
R14* 12 (15)
R15* 27 (62)
A3 POWER SUPPLY ASSEMBLY
Q5 9510-0002
R11 25 5W
R10 4700
R1 49.9K ±1%
R4 30K
Q2 9510-0003
Q3 9510-0003
R7 43K 38K
R2 2500 ±20% 1W
Q1 9510-0003
Q4 9510-0003
R9 18K 47K
R8 10K
C1 300-75v
(C2) 300 75v
CR2 9210-0009
CR3 9210-0009
CR1 9200-0002
R3 10K ±1% 1/8W
R5 3900
R6 5600
S1B
Q1 9410-0004
CR4 9210-5003
R1 82
CR1 9210-5003
CR2 9210-5003
CR3 9210-5003
CR5 9210-5003
R2 30K
** A4 CHARGER ASSEMBLY
BLK
WHT
GRN
W1
P1 PIN VIEW
J1 REAR VIEW
C1A .01
C1B .01
F1
S1A
LINE
DS1
S2
115V
230V
BLK
YEL-BLK
BRN
YEL-BRN
T1
YEL
ORN
RED
X.0001
S1B1
S1A1
R1 244.4
C1 15pf
R2 1980
R3 1980
R4 244.4
C2 15pf
R5 1980
R6 1980
R7 244.4
C3 15pf
R8 270K
R9 220
C4 15pf
A5 ATTENUATOR ASSEMBLY
ALL RESISTORS EXCEPT R8 ±1/2%, 1/8W



NOTES:

1– ⏚ CABINET GROUND.
2– ✻ AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY, PART MAY BE OMITTED
3– ✻✻ ON BATTERY OPERATED MODEL ONLY.
4– CAPACITOR VALUES UF UNLESS OTHERWISE SPECIFIED
5– CAPACITOR VOLTAGE 500 V UNLESS OTHERWISE SPECIFIED.
6– ALL RESISTORS ± 5%, 1/2 W.
7– DOTTED CONNECTIONS AND VALUES IN PARENTHESES USED ON MODEL 603 A.
8– A5 ATTENUATOR ASSEMBLY ON MODEL 602 A ONLY.
9– A6 ATTENUATOR ASSEMBLY ON MODEL 603 A ONLY

DATE	BY	CHANGE	APPR.

GAUSSIAN NOISE GENERATOR

DATE	APPROVED BY	DRAWN BY
JUNE 14, 1965	D L Royal	sld

ELGENCO INCORPORATED
SANTA MONICA, CALIFORNIA

DRAWING NUMBER 602A/603A

PARTS LIST

SECTION 7

REPLACEABLE PARTS LIST

ORDERING PARTS

Standard components may be purchased locally or from Elgenco; special parts should be ordered from Elgenco. When ordering from Elgenco, always include:

1. The Elgenco part number
2. Complete description of part including circuit designation.
3. Model and serial number of the instrument.
4. If part number is not listed, give complete description, function, and location of part.

If the part which is ordered has been replaced by a new or improved part, the new part will be supplied. Where necessary, replacement information will be provided.

REFERENCE DESIGNATORS

A	assembly	E	misc electronic part	MP	mechanical part	TB	terminal board
B	motor	F	fuse	P	plug	TP	test point
BT	battery	FL	filter	Q	transistor	V	vacuum tube, neon bulb, photocell, etc.
C	capacitor	J	jack	R	resistor		
CP	coupling	K	relay	RT	thermistor	W	cable
CR	diode	L	inductor	S	switch	X	socket
DL	delay line	M	meter	T	transformer	Y	crystal
DS	device signaling (lamp)						

ABBREVIATIONS

A	ampere	GE	germanium	NC	normally closed	RS	recommended spares, one year isolated service
AFC	automatic frequency control	GL	glass	NE	neon		
AMPL	amplifier	GMV	guaranteed minimum value	NICAD	nickel-cadmium	SB	slow-blow
AV	average value shown, optimum value selected at factory, part may be omitted	GRD	ground(ed)	NI PL	nickel plate	SCR	silicon controlled rectifier
				NO	normally open		
		H	henry	NPO	negative positive zero (zero temperature coefficient)	SE	selenium
BFO	beat frequency oscillator	HEX	hexagonal			SEC	second(s)
BE CU	beryllium copper	HG	mercury	NRFR	not recommended for field replacement	SECT	section(s)
BH	binder head	HPF	high pass filter			SEMICON	semiconductor
BP	bandpass	HR	hour(s)	NS	nanosecond	SI	silicon
BRS	brass			NSR	not separately replaceable	SIL	silver
		IF	intermediate freq			SL	slide
CCW	counter-clockwise	IMPG	impregnated			SM	silver mica
CER	ceramic	INCD	incandescent	OBD	order by description	SPL	special
CF	carbon film	INCL	include(s)	OF	oil filled	SST	stainless steel
CI	cad-iridite	INS	insulation(ed)	OH	oval head	SR	split ring
CMO	cabinet mount only	INT	internal	OX	oxide	STL	steel
COEF	coefficient					SW	switch
COM	common	K	kilohm	P	paper	TA	tantalum
COMP	composition			PC	printed circuit	TC	temperature coefficient
CONN	connector	LIN	linear taper	PF	picofarad		
CP	cadmium plate	LK WASH	lock washer	PH BRZ	phosphor bronze	TD	time delay
CRT	cthode-ray tube	LOG	logarithmic taper	PHL	Phillips	TI	titanium
CW	clockwise	LPF	low pass filter	PIV	peak inverse voltage	TOG	toggle
		M	megohm	PK	peak	TOL	tolerance
DEG	degrees	MAX	maximum	P/O	part of	TRIM	trimmer
DEV	deviation	MBO	may be omitted in some cases	POLY	polystyrene	TQ	total quantity
DI	dioxide			PORC	porcelain		
DR	drive	MF	metal film	POS	position(s)	UF	microfarad
		MFR	manufacturer	PP	peak-to-peak	UH	microhenry
ELECT	electrolytic	MIN	minute(s)	PT	point	US	microsecond
ENCAP	encapsulated	MINAT	miniature			VAR	variable
EXT	external	MOM	momentary	RECT	rectifier		
		MP	mylar paper	RF	radio frequency	W	watts
F	farad	MS	millisecond	RH	round head	W/	with
FH	flat head	M/S	machine screw	RMO	rack mount only	W/O	without
FIL H	fillister head	MTG	mounting	RMS	root-mean-square	WVDC	working volts dc
FXD	fixed	MY	mylar	ROT	rotary	WW	wirewound

Replaceable Parts List

Reference Designation	Description	MFR	Elgenco Stock No.	TQ	RS
A1	ASSY, AMPLIFIER	15455	8611-8101	1	
A1A1	ASSY, NOISE SOURCE AND PREAMPLIFIER, ENCAP	15455	8611-8111	1	1
A1C1	C, FXD ELECT 100 UF ±20% 25 WVDC	15455	4000-6107	2	1
A1C2	C, FXD ELECT 270 UF ±20% 12 WVDC	15455	4000-3277	5	1
A1C3					
A1C4	C, FXD MP 0.0056 UF ±5% AV 600 WVDC	72136	3456-0562	2	2
A1C5	C, FXD SM 270 PF ±5% AV 500 WVDC	72136	3155-0271	2	2
A1C6	SAME AS A1C2				
A1C7	SAME AS A1C2				
A1C8	SAME AS A1C3				
A1C9	SAME AS A1C4 AV				
A1C10	SAME AS A1C5 AV				
A1C11	C, FXD ELECT 330 UF ±20% 3 WVDC	15455	4000-0337	3	1
A1C12 THRU					
A1C13	C, FXD SM 91 PF ±5% AV 500 WVDC	72136	3155-0910	2	1
A1C14	C, FXD ELECT 250 UF +100 -10% 30 WVDC	56289	4090-7257	1	1
A1C15	SAME AS A1C1				
A1C16	C, FXD ELECT 100 UF ±20% 15 WVDC	15455	4000-4107	1	1
A1Q1	TRANSISTOR, SILICON PNP SELECTED	15455	9410-0003	2	2
A1Q2	TRANSISTOR, SILICON NPN SELECTED	15455	9410-0004	2	2
A1Q3	SAME AS A1Q1				
A1Q4	SAME AS A1Q2				
A1R1	R, FXD COMP 15K ±5% 1/2W	78488	1352-1502	3	1
A1R2	R, FXD COMP 6.8K ±10% 1/2W	78488	1392-6801	2	1
A1R3	R, FXD COMP 820 OHM ±5% 1/2W	78488	1352-8200	1	1
A1R4	R, VAR COMP 250 OHM ±20% 3/10W	15455	0601-2500	1	1
A1R5	R, FXD COMP 22 OHM ±5% 1/2W	78488	1352-0220	1	1
A1R6	R, FXD MF 499 OHM ±1% 1/8W	19701	1919-4990	2	1
A1R7	R, FXD COMP 30K ±5% 1/2W	78488	1352-3002	3	1
A1R8	SAME AS A1R1				
A1R9	R, FXD COMP 18K ±10% 1/2 W	78488	1392-1802	1	1
A1R10	R, FXD COMP 8.2K ±5% 1/2W	78488	1352-8201	1	1
A1R11	SAME AS A1R2	78488	1392-6801	2	1
A1R12	R, FXD COMP 2.2K ±5% 1/2W	78488	1352-2201	1	1
A1R13	R, FXD COMP 2.7 OHM ±5% AV 1/2W		1352-2708	1	1
AIR14	R, fxd comp 15 OHM ±5% AV 1/2W	78488	1352-0150	1	1
A1R15	R. FXD COMP 47 OHM ±5% AV 1/2W	78488	1352-4709	1	1

Figure 7-1 Replaceable Parts List (cont'd)

Reference Designation	Description	MFR	Elgenco Stock No.	TQ	RS
A1R16	R, FXD MF 332 OHM ±1% 1/2W	75042	1912-3320	1	1
A1R17	R, FXD MF 53.6K ±1% 1/2W	75042	1912-5362	1	1
A1R18	R, FXD MF 4.75K ±1% 1/8W	19701	1919-4751	1	1
A1R19	R, FXD COMP 1K ±5% 1/2W	78488	1352-1001	2	1
A1R20	R, FXD MF 4.99K ±1% 1/4W	19701	1911-4991	1	1
A1R21	SAME AS A1R6				
A1R22	R, FXD MF 909 OHM ±1% 1/2W	75042	1912-9090	2	1
A1R23	SAME AS A1R22				
A1R24	SAME AS A1R19				
A1R25	R, FXD COMP 6.2K ±5% 1/2W	78488	1352-6201	1	1
A1S1	SWITCH, ROTARY 3 POLE 3 POSITION	15455	7311-8101	1	1
A2	ASSY, OUTPUT METER	15455	8611-8102	1	1
A2C1	C, FXD SM ~~12~~ PF ±5% 500 WVDC AV	72136	3155-0240	1	1
A2C2	SAME AS A1C11				
A2C3	SAME AS A1C11				
A2CR1 THRU A2CR2	DIODE, GE	15455	9310-2002	2	3
A2M1	METER, OUTPUT 5V RMS SCALE	15455	2201-0003	1	1
A2R1	SAME AS A1R20				
A2R2	R, VAR COMP 800 OHM ±20% 3/10W	15455	0101-8000	1	1
A2R3 THRU A2R4	R, FXD MF 3.83 ±1% 1/4W	19701	1911-3831	2	1
A3	ASSY, POWER SUPPLY	15455	8611-8103	1	
A3C1	C, FXD 300 UF +75 -10% 75 WVDC	15455	4090-9307	1	1
A3CR1	DIODE, SILICON ZENER	15455	9200-0002	1	1
A3CR2 THRU A3CR3	DIODE, SILICON, RECT	15455	9210-0009	2	2
A3Q1 THRU A3Q4	TRANSISTOR, GE PNP, SELECTED	15455	9510-0003	4	4
A3Q5	TRANSISTOR, GE PNP	15455	9510-0002	1	1
A3R1	R, FXD MF 49.9K ±1% 1/2W	75042	1912-4992	1	1
A3R2	R, VAR WW 2.5K ±20% 1W	15455	0203-2501	1	1
A3R3	R, FXD MF 10K ±1% 1/8W	19701	1919-1002	1	1
A3R4	SAME AS A1R7				
A3R5	R, FXD COMP 3.9K ±5% 1/2W	78488	1352-3901	1	1

Figure 7-1 Replaceable Parts List (cont'd)

Reference Designation	Description	MFR	Elgenco Stock No.	TQ	RS
A3R6	R, FXD COMP 5.6K ±5% 1/2W	78488	1352-5601	1	1
A3R7	SAME AS A1R7				
A3R8	R, FXD COMP 10K ±5% 1/2W	78488	1352-1002	1	1
A3R9	SAME AS A1R1				
A3R10	R, FXD COMP 4.7K ±5% 1/2W	78488	1352-4701	1	1
A3R11	R, FXD W W 25 OHM ±5% 5W	56289	1456-0250	1	1
A4	ASSY, BATTERY CHARGER BATTERY OPTION ONLY	15455	8611-8104	1	
A4CR1 THRU A4CR5	DIODE, SILICON	15455	9210-5003	5	5
A4Q1	TRANSISTOR, SILICON NPN	15455	9410-0004	1	1
A4R1	R, FXD COMP 82 OHM ±5% 1/2W	78488	1352-0820	1	1
A4R2	SAME AS A1R7				
A5	ASSY, ATTENUATOR	15455	8611-8105	1	
A5C1 THRU A5C4	C, FXD SM 15 PF ±5% 500 WVDC	72136	3155-0510	4	1
A5R1	R, FXD MF 244.4 OHM ±1/2%, 1/8W	19701	1939-2440	3	1
A5R2 THRU					
A5R3	R, FXD MF 1.98K ±1/2% 1/8W	19701	1939-1981	4	1
A5R4	SAME AS A5R1	19701	1939-2440	3	1
A5R5 THRU					
A5R6	SAME AS A5R2				
A5R7	SAME AS A5R1				
A5R8	R, FXD COMP 270K ±5% 1/2W	78488	1352-2703	1	1
A5R9	R, FXD MF 220 OHM±1/2% 1/8W	19701	1939-2200	1	1
A5S1	SWITCH, ROTARY 5 POS NOT SEPARATELY REPLACEABLE	15455	7311-8201	1	
BT1	BATTERY, NICAD RECHARGEABLE 0.6 AMP HOUR, BATTERY OPTION ONLY	88220	7340-1181	1	
C1, A, B	C, FXD CERAMIC 2 X0.01 UF GMV 1000 WVDC	56289	3986-4103	1	1
DS1	LAMP, LINE	15455	7110-2021	1	1
F1	FUSE, 3AG 1/8 AMP 250 VOLT SB	75915	7210-2002	1	10

Figure 7-1 Replaceable Parts List (cont'd)

Reference Designation	Description	MFR	Elgenco Stock No.	TQ	RS
J1	CONNECTOR, POWER	15455	7510-1104	1	1
J2	BINDING POST, RED	15455	7471-0017	1	1
	BINDING POST, BLACK	15455	7471-0018	1	1
	DUAL MOUNTING BASE, BLACK	15455	7471-0019	1	1
R1	R, VAR COMP 2K ±20% 1/2W	15455	0102-2001	1	1
S1, A, B	SWITCH, TOGGLE 2PST	88140	7311-8001	1	1
S2	SWITCH, SLIDE DPDT	15455	7311-6901	1	1
T1	TRANSFORMER, RECTIFIER	15455	6111-8001	1	1
W1	CABLE, POWER	15455	7080-0004	1	1
XF1	FUSE HOLDER	75915	7210-6011	1	1
	MISCELLANEOUS				
	KNOB, BAR	15455	7320-0106	2	1
	KNOB, ROUND	15455	7320-0105	1	1
	COVER, SIDE	15455	9611-6003	2	
	COVER, TOP	15455	9611-6004	1	
	COVER, BOTTOM	15455	9611-6005	1	
	PANEL, FRONT	15455	9711-8001	1	
	PANEL, REAR	15455	9711-6002	1	
	ROD	15455	9711-6016	4	
	PLATE, FRONT	15455	9711-8002	1	
	PLATE, REAR	15455	9711-8003	1	
	PLATE, POWER SUPPLY	15455	9711-8004	1	
	SHIELD, OUTPUT CONNECTOR	15455	9711-6018	1	
	SHIELD, SIDE	15455	9711-8005	2	
	CLAMP, BATTERY BATTERY OPTION ONLY	15455	9711-8006	1	
	STAND, TILT	15455	9711-6101		
	FOOT	15455	7330-0001	4	
	MANUAL, OPERATING AND SERVICE	15455	7795-1180	1	

MANUAL
CHAMOIS

ELGENCO MANUAL CHANGES

MODEL 602A
SOLID STATE NOISE GENERATORS

Manual Serial Number Prefixed 026-

To adapt this manual to instruments with other serial prefixes check for errata below, and make changes shown in tables.

Instrument Serial Prefix	Make Manual Changes
ALL	Errata
043-	1, 6
045-	1, 2, 6

Instrument Serial Prefix	Make Manual Changes
060-	1, 2, 3, 6
061-	1, 2, 3, 4, 6
076	1, 2, 3, 5

Instrument Serial Prefix	Make Manual Changes

ERRATA:
Page 7-2

A1C2: Was under TQ 5 Now under TQ 3
A1C3: Was SAME AS A1C2 Now C, Fxd Elect 10uf ±20% 15 WVDC --15455--4000-4106--2--1
A1C8: Was SAME AS A1C2 Now SAME AS A1C3

CHANGE #1
Page 6.5, TABLE 6-1

Was	A3Q1	5.1	5.8	19.0	Now	A3Q1	5.1	5.8	19.0
	A3Q2	15.7	15.8	30.0		A3Q2	18.8	19.0	30.0
	A3Q3	15.7	15.8	30.2		A3Q3	18.8	19.0	30.2
	A3Q4	5.1	5.2	15.8		A3Q4	5.1	5.8	19.0

ON SCHEMATIC AT A3 POWER SUPPLY ASSEMBLY

Q1 and Q2	Were	9510-0003	Now	9410-0010
R4 and R7	Were	30k	Now	43k
R6	Was	5600	Now	10k
R9	Was	15k	Now	4700
R10	Was	4700	Now	7500

Page 7-3

A3 Was for stock number 8611-8103 Now for stock number 8611-9103

Add between A3CR3 Thru A3Q4: A3Q1 Thru A3Q2--Transistor, SI, PNP--15455--9410-0010--2--2

A3Q1 Thru A3Q4	Were	A3Q1 Thru A3Q4--Transistor, GE, PNP, Selected--15455--9510-0003--4--4	Now	A3Q3 Thru A3Q4--Transistor, GE, PNP, 15455--9510-0003--2--2

A3R4: Was SAME AS A1R7 Now R, Fxd Comp 43k ±5% 1/2w-- 78488--1352-4302--2--1

Page 7-4

A3R6:	Was R, Fxd, comp 5.6k ±5% 1/2w-- 78488--1352-5601--1--1	Now R, Fxd comp 10k ±5% 1/2w 78488--1352-1002--2--1
A3R7	Was SAME AS A1R7	Now SAME AS A3R4
A3R8	Was R, Fxd Comp 10k ±5% 1/2w-- 78488--1352-1002--1--1	Now SAME AS A3R6
A3R9	Was SAME AS A1R1	Now R, Fxd Comp 4.7k ±5% 1/2w 78488--1352-4701--1--1
A3R10	Was R, Fxd Comp 4.7k ±5% 1/2w-- 78488--1352-4701--1--1	Now R, Fxd Comp 7.5k ±5% 1/2w 78488--1352-7501--2--1

CHANGE #2

Page 6-5, TABLE 6-1

Was	A1Q1	8.3	8.9	11.8	Now	A1Q1	9.0	8.3	10.8
	A1Q2	12.4	11.8	4.3		A1Q2	11.4	10.8	5.2

ON SCHEMATIC AT A1 AMPLIFIER ASSEMBLY:

R25	Was 6200	Now 5600
R9	DELETE ±10%	
R10	Was 8200	Now 7500
R11	Was 6800 ±10%	

Page 7-2

A1R9	Was R, Fxd Comp 18k ±10% 1/2w-- 78488--1392-1802--1--1	Now R, Fxd Comp 18k ±5% 1/2w-- 78488--1352-1802--1--1
A1R10	Was R, Fxd Comp 8.2k ±5% 1/2w-- 1352-8201--1--1	Now R, Fxd Comp 7.5k ±5% 1/2w 1352-7501--2--1
A1R11	Was SAME AS A1R2--78488-- 1392-8201--1--1	Now SAME AS A1R10

CHANGE #3

Page 7-2

A1C14 Was C, Fxd Elect 250 UF +100 -10% 30 WVDC 56289 4090-7257-1-1
Now C, Fxd Elect 150 UF +75 -10% 40 WVDC 56289 4099-8157-1-1

CHANGE #4

Page 7-5

COVER, SIDE	Was 9711-6003	Now 9712-9003
PANEL, FRONT	Was 9711-8001	Now 9712-9001
PANEL, REAR	Was 9711-8002	Now 9712-9002

A3R4:	Was SAME AS A1R7	Now R, Fxd Comp 43k ±5% 1/2w--78488--1352-4302--2--1

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A3R6:	Was R, Fxd, Comp 5.6k ±5% 1/2w--78488--1352-5601--1--1	Now R, Fxd Comp 10k ±5% 1/2w 78488--1352-1002--2--1
A3R7	Was SAME AS A1R7	Now SAME AS A3R4
A3R8	Was R, Fxd Comp 10k ±5% 1/2w--78488--1352-1002--1--1	Now SAME AS A3R6
A3R9	Was SAME AS A1R1	Now R, Fxd Comp 4.7k ±5% 1/2w 78488--1352-4701--1--1
A3R10	Was R, Fxd Comp 4.7k ±5% 1/2w--78488--1352-4701--1--1	Now R, Fxd Comp 7.5k ±5% 1/2w 78488--1352-7501--2--1

CHANGE #2

Page 6-5, TABLE 6-1

Was	A1Q1	8.3	8.9	11.8	Now	A1Q1	9.0	8.3	10.8
	A1Q2	12.4	11.8	4.3		A1Q2	11.4	10.8	5.2

ON SCHEMATIC AT A1 AMPLIFIER ASSEMBLY:

R25	Was	6200	Now	5600
R9	DELETE ±10%			
R10	Was	8200	Now	7500
R11	Was	6800 ±10%	Now	7500

Page 7-2

A1R9	Was R, Fxd Comp 18k ±10% 1/2w 78488--1392-1802--1--1	Now R, Fxd Comp 18k ±5% 1/2w--78488--1352-1802--1--1
A1R10	Was R, Fxd Comp 8.2k ±5% 1/2w 1352-8201--1--1	Now R, Fxd Comp 7.5k ±5% 1/2w--1352-7501--2--1
A1R11	Was SAME AS A1R2--78488--1392-8201--1--1	Now SAME AS A1R10

Page 7-3

A1R25	Was R, Fxd Comp 6.2k ±5% 1/2w 78488--1352-6201--1--1	Now R, Fxd Comp 5.6k ±5% 1/2w 78488--1352-5601--1--1

CHANGE #3

Page 7-2

A1C14 Was C, Fxd Elect 250 uf +100 -10% 30 WVDC 56289 4090-7257-1-1
Now C, Fxd Elect 150 uf +75 -10% 40 WVDC 56289 4099-8157-1-1

CHANGE #4

Page 7-5

COVER, SIDE	Was 9711-6003	Now 9712-9003
PANEL, FRONT	Was 9711-8001	Now 9712-9001
PANEL, REAR	Was 9711-8002	Now 9712-9002

CHANGE #5

Page 2-1

Add for Model 602A-200
Spectrum Uniformity ±5.0 db, 500 kHz to 5 mHz
Change Output Impedance

Was	900 ohms ±10%
Now	200 ohms ±10%

Page 2-2

MAXIMUM LOAD

Was	No Limit
Now	700 ohms

Page 7-3

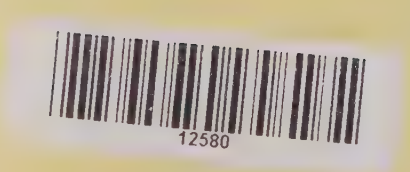
A1R24	Was	SAME AS A1R19
	Now	R, FXD COMP 180 ohm, ±5%, 1/2 w -- --78488--1352--1800--1--1

CHANGE #6

Page 2-1

OUTPUT STEP ATTENUATOR
OUTPUT IMPEDANCE

Was	200 ohms ±1%
Now	200 ohms ±5%



INSTRUCTION MANUAL

A32177

EMR MODEL 4145
CONSTANT BANDWIDTH (CBW)
TUNABLE DISCRIMINATOR
(REVISION H)

(SERIAL NO. 80 AND UP)
S/N 93

EMR

EMR Schlumberger

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MAY 1975

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LIST OF EFFECTIVE PAGES

Dates of issue for basic and revisions are:

Basic	October 1968
Revision A	January 1969
Revision B	May 1969
Revision C	December 1969
Revision D	May 1970
Revision E	September 1970
Revision F	May 1971
Revision G	June 1972
Revision H	May 1975

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual contains information describing the operation and maintenance of the EMR Model 4145 Constant Bandwidth (CBW) Tunable Discriminator. Included in this information are physical and functional descriptions, specifications, installation and operating instructions, theory of operation, maintenance data, and equipment parts lists.

The Model 4145 is a precision solid-state instrument intended for rack mounting in an FM data-processing or checkout system. The discriminator is designed to separate subcarrier signals from an FM multiplex input and demodulate the intelligence by pulse-averaging detection. The FM subcarrier center frequency range is from 5 KHz to 1.6 MHz, selectable to five significant digits. The output filter is tunable for data-cutoff frequencies from 10 Hz to 30 KHz with the output response selectable for either constant amplitude (CA) or constant delay (CD) characteristics. Subcarrier center frequencies, deviations, data-cutoff frequencies, and output filter response characteristics may be manually selected at the front panel or may be remotely programmed from an external source.

1.2 FUNCTIONAL DESCRIPTION

The EMR Model 4145 CBW Tunable Discriminator, shown in Figure 1-1, buffers the input multiplex signal and then filters the signal for noise limiting and image rejection. The filtered signal is applied to the first IF mixer together with a VCO input which is regulated by the tape speed compensation (TSC) signal and tuning control signals. The resultant up-converted intermediate frequency is free from tape-speed errors, and the discriminator bandwidth does not severely limit the TSC at the bandedges.

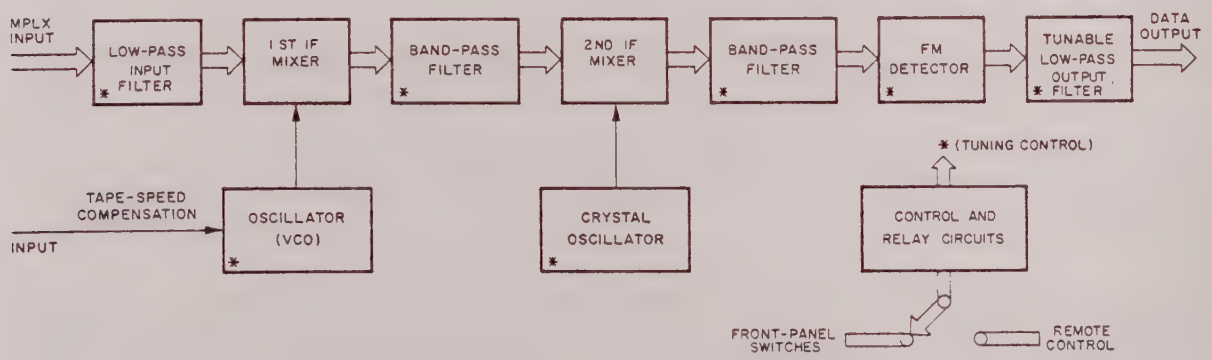


Figure 1-1. Model 4145 CBW Tunable Discriminator Simplified Block Diagram

The output of the first IF mixer is filtered and applied to the second IF mixer along with a very stable frequency derived from a 12.8 MHz crystal oscillator. The second IF mixer down converts the signal received from the first IF mixer to a new center frequency and bandwidth. This IF signal is again filtered for image and adjacent channel rejection, and then demodulated by a 6.25% pulse averaging FM detector. The output of the detector drives a tunable low-pass output filter (LPOF) with a cutoff frequency selectable by front panel thumbwheel switches.

1.3 PHYSICAL DESCRIPTION

The EMR Model 4145 CBW Tunable Discriminator is a self-contained unit designed for mounting in a standard 19-inch equipment rack. Various types of mounting hardware may be provided with the discriminator as required for various installation configurations. (Refer to Figure 2-3, Model 4145 Variable Chart.) The overall physical dimensions of the discriminator are 19 inches wide by 5-1/4 inches high by 20-1/4 inches in depth.

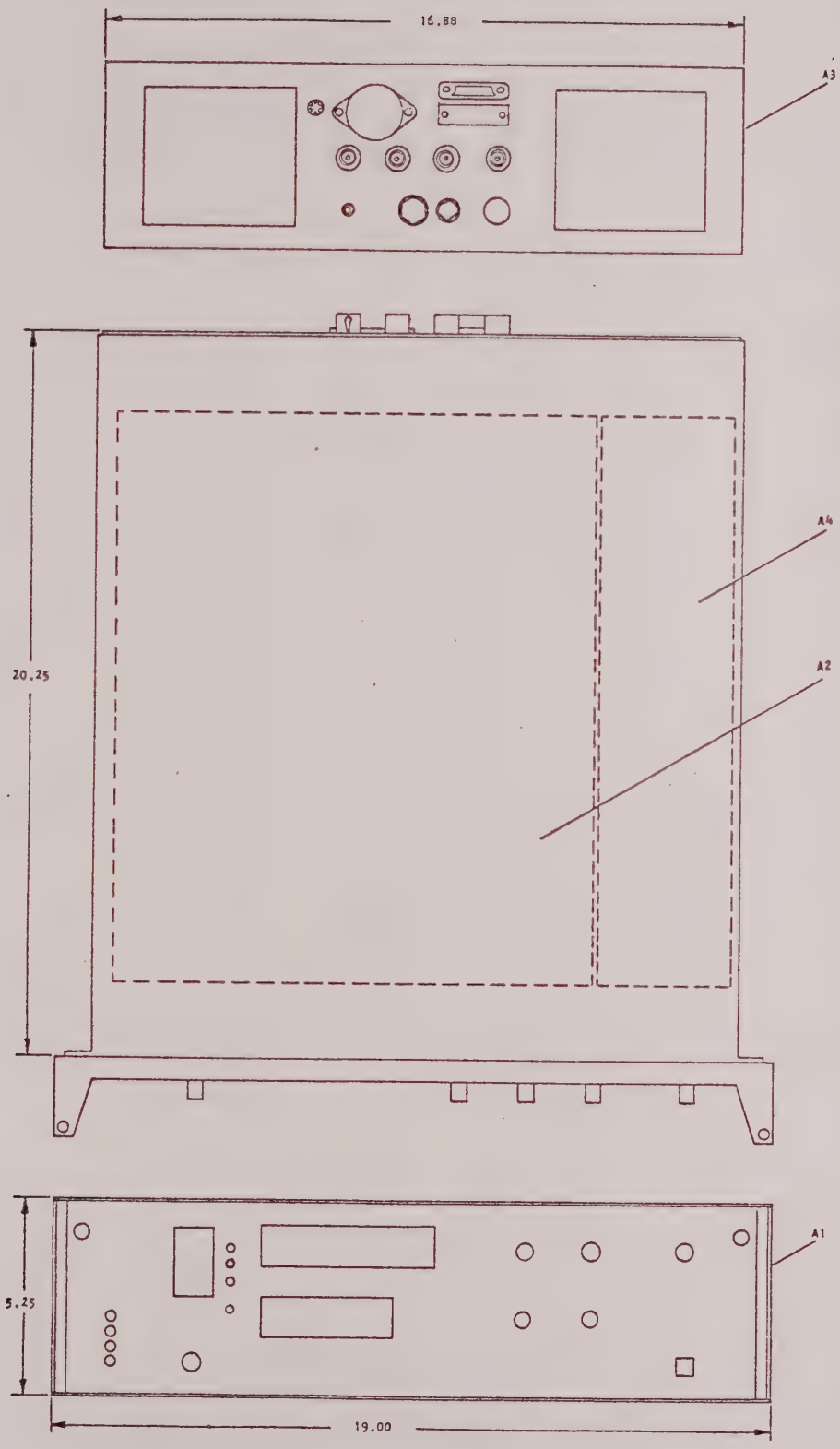
The Model 4145 is composed of four major subassemblies as shown in Figure 1-2. These assemblies are identified by assembly designations A1 through A4 as follows:

A1 -- Front Panel/Subpanel Assembly
A2 -- Card File Chassis Assembly
A3 -- Rear Panel Assembly
A4 -- Power Supply

Front panel/subpanel assembly A1 is a two-segment assembly in which all operating controls, indicators, and test jacks are mounted directly to the subpanel and extend through precut opening in the front panel. Also, the front panel/subpanel contains turn-to-lock catches used to secure the discriminator in the mounting rack.

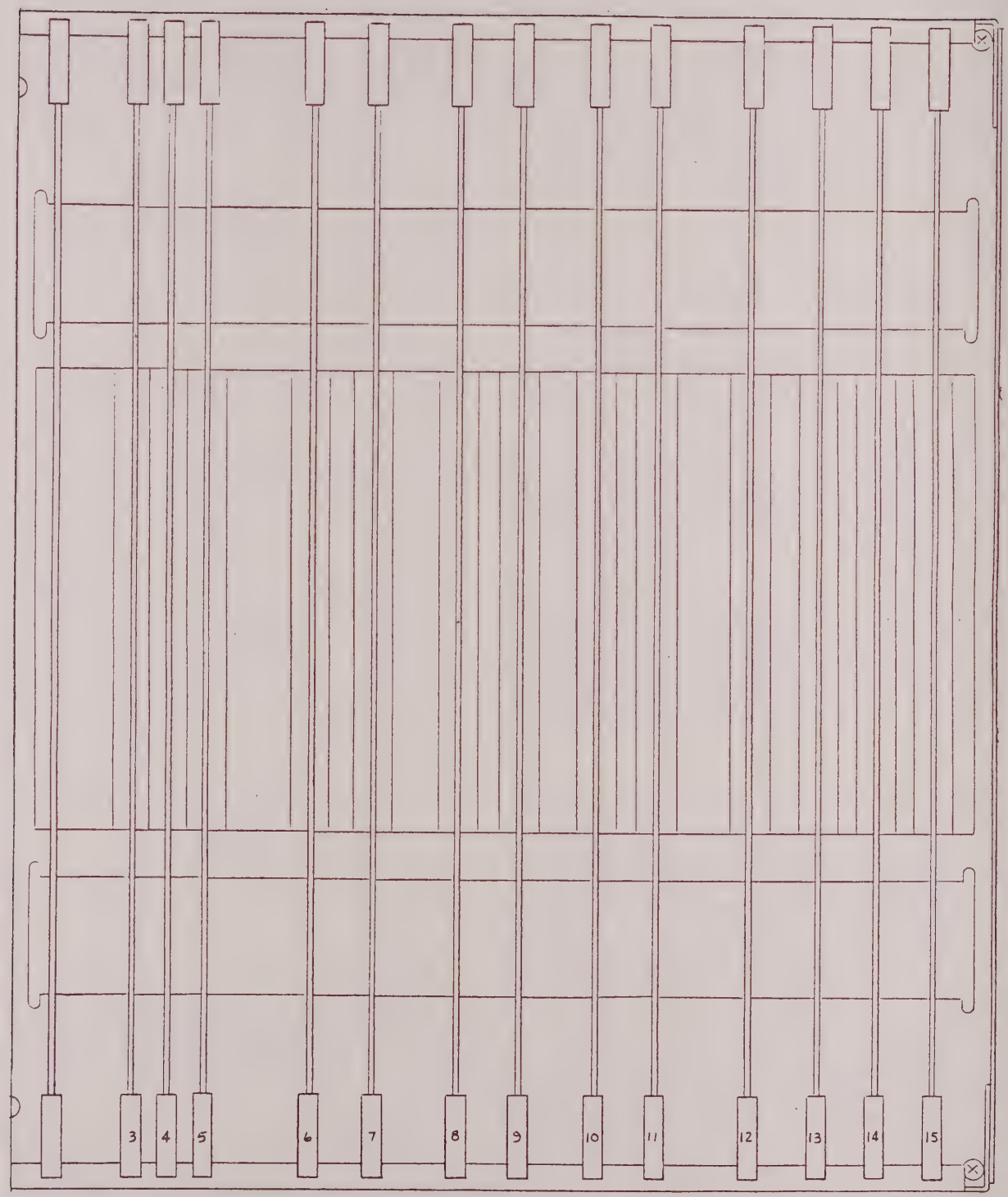
Card file chassis assembly A2 provides mounting locations for the plug-in printed-wiring cards used in the Model 4145 discriminator. Provisions are made for up to 15 printed-wiring cards; however, present configurations of the discriminator use only 14 card locations. The card file layout is shown in Figure 1-3 and the function of each card is described in Table 1-1. Access to assembly A2 is obtained by releasing the quick-disconnect fasteners in the top cover of the discriminator and removing the cover. Cam operated ejectors on both ends of the printed-wiring cards facilitate removal of the cards from the mounting locations.

Rear panel assembly A3 contains electrical connectors for all input and output connections to the discriminator. A twist-lock power plug is provided for the AC power input to the power supply. A rear panel mounted 1.5 ampere slo-blow fuse, connected in series with the AC power input, provides protection from the AC power source. Internal cooling is provided by a blower mounted vertically



NOTE: Made from Dwg. Control No. 4140-001

Figure 1-2. EMR Model 4145 CBW Tunable Discriminator Major Assemblies



NOTE: Made from EMR Dwg. No. 14982, Rev. B

Figure 1-3. Card-Tray Assembly A2 Printed-Circuit Card Complement

Table 1-1. Card-File Chassis Assembly A2
Printed-Wiring Card Descriptions

DESIG-NATION	NAME	TYPE	FUNCTION
A2A1	Extender Card	14199	Used to extend other printed-wiring cards from normal operating positions for test and maintenance.
A2A2	Not Used		
A2A3	BCD Converter Card	14827	Contains circuitry for identifying subcarrier channel selected by front panel thumbwheel switches.
A2A4	Binary Counter Card	14098	Contains circuitry which provides fine and coarse tuning control lines.
A2A5	Harmonic Selector Card	15167	Produces basic operating frequencies from the 12.8 MHz input and processes the coarse tuning inputs from A2A4.
A2A6	VCO and Harmonic Mixer Card	17162	Provides frequency-band selection inputs to all cards and provides a local oscillator input to the first IF card, A2A9, representing the specific channel selected.
A2A7	Input Level Adjust and VCO Modulator	15155-1	Provides input to VCO A4A1A1 representing fine tuning requirements of subcarrier channel selected and tape-speed compensation. Also contains circuitry for input level detection and automatic ranging control of front panel INPUT meter.
A2A8	Delay Line and Low-Pass Card	14101	Provides necessary delays for time correlation between tape-speed error and correction. Improves signal-to-noise by limiting input bandwidth.
A2A9	First IF Card	15146	Contains two mixer stages and selectable bandpass filters associated with tuning to a selected subcarrier channel.

Table 1-1 (Cont'd). Card-File Chassis Assembly A2
Printed-Wiring Card Descriptions

DESIG-NATION	NAME	TYPE	FUNCTION
A2A10	Second IF Card	15161	Contains bandpass filters associated with the output of the second mixer stage on A2A9.
A2A11	Detector Card	17168	Contains circuitry for demodulating subcarrier intelligence by pulse averaging detection.
A2A12	Single Pole Card	17165	Contains first stage of a five-pole tunable low-pass output filter. Also contains circuitry associated with meter ranging control.
A2A13	Pole Pair Card	15152-2	Contains second and third stages of five-pole tunable low-pass output filter.
A2A14	Pole Pair Card	15152-3	Contains fourth and fifth stages of five-pole tunable low-pass output filter.
A2A15	Regulator/ Output Amplifier Card	14823-1	Contains five DC voltage regulator circuits (+18V, +20V, +5.2V, -5.2V, and -18V) and the output amplifier circuit.

on the inside of the rear panel. The blower draws cooling air in through a screen on the opposite end of the rear panel and discharges the air through the blower opening.

Power supply assembly A4 contains a power transformer, diode rectifiers, and series-regulator transistors which, in conjunction with the voltage regulation circuits on card A2A15, provide the primary DC operating voltages for the discriminator. In addition, assembly A4 contains an oven assembly, A4A1, which houses a VCO, a crystal oscillator, a reference regulator, and a temperature regulator. These circuits are mounted on two printed-wiring cards, A4A1A1 and A4A1A2. The power supply assembly is located adjacent to the card file chassis assembly in the middle section of the discriminator.

1.4 SYSTEM APPLICATIONS

The EMR Model 4145 is part of the 4000-Series of tunable FM modulation and demodulation equipment. These units are designed for simplified operator control and versatility and convenience in setting up system parameters. A typical system application is shown in Figure 1-4. The Model 4145 accepts single channel or multiplex information, in either real time or prerecorded, and extracts the modulating data. The analog data output of the Model 4145 can be used as an input to recorders, quick-look devices, or for further processing. For remote operation, the operating parameters for subcarrier channels are selected by an external device; such as, remote control panel, or an EMR Model 4141-05 Programmer. The Model 4141-05 is programmed for CBW IRIG channels 1A through 21A with two spare channels which may be programmed by the customer.

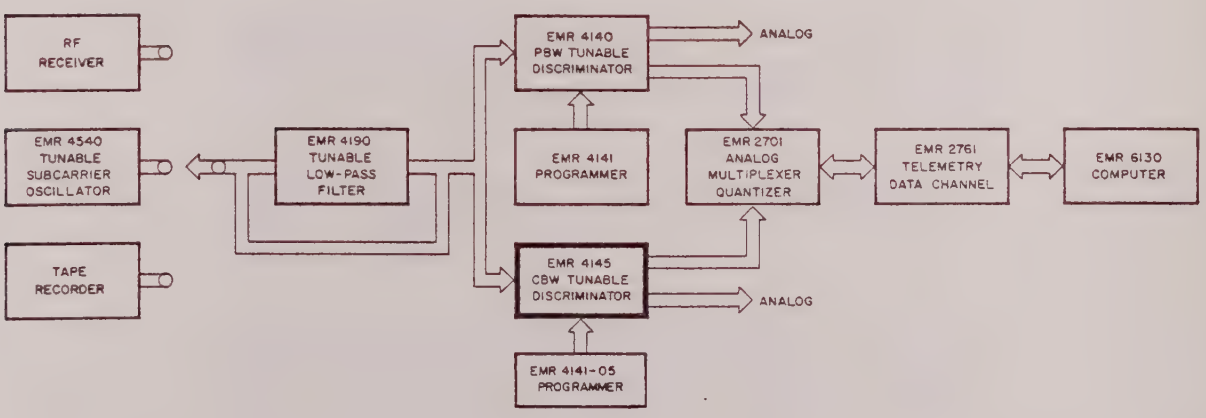


Figure 1-4. Typical System Application

SECTION 2

SPECIFICATIONS

2.1 GENERAL

This section outlines the electrical, mechanical, and environmental specifications for the EMR Model 4145 CBW Tunable Discriminator. Figure 2-3 of this section provides part number identification for the Model 4145.

2.2 ELECTRICAL SPECIFICATIONS

a. Center Frequency and Deviation: Five discrete frequency bands selectable as a function of deviation. Center frequencies within each band selectable in 100 Hz increments with setup resolution and accuracy of ±1% of bandwidth.

Band	Deviation (KHz)	Range (KHz)
A	±1	5 to 100
B	±2	10 to 200
C	±4	20 to 400
D	±8	40 to 800
E	±16	80 to 1600

b. Input Impedance: 10K shunted by not more than 100 picofarad.

c. Input Configuration: Single-ended, referenced to ground.

d. Input Signal Range: 10 millivolts RMS through 5 volts RMS for frequency bands A, B, and C. (See specification a.) 50 millivolts RMS through 5 volts RMS for frequency bands D and E.

e. Maximum Input Signal: 10 volts peak composite signal. Signals as large as 100 volts peak will not damage the unit.

f. Amplitude Modulation Rejection: The output transient is not more than 1.0% of full bandwidth for a 20 Db step change (occurring anywhere within the input signal range) in subcarrier amplitude at center frequency with a deviation ratio of 5.

g. Output Impedance: Not greater than 1 ohm.

h. Output Voltage and Current: Single-ended and referenced to ground. Bandedge voltage is adjustable between ±0.1 and ±10 volts; peak current limited, 100 milliamperes minimum, 140 milliamperes maximum.

i. Deviation Sense: Positive or negative sensitivity is selectable by front panel switch.

j. Output Zero Stability: Zero drift not greater than ±0.25% of full bandwidth in a 15-hour period after a 30-minute warm-up at a constant (±3°C) ambient temperature. Drift not greater than ±0.5% of full bandwidth output throughout the operating temperature range of +10° to +50°C.

k. Data Cutoff Frequencies: 10 Hz to 30 KHz as determined by front panel thumbwheel switches.

l. Data Response: Constant amplitude (CA) or constant dealy (CD) output response characteristics selectable by front panel switch. Cutoff characteristic asymptotically approaches 30 Db/octave beyond cutoff. (Refer to Figures 2-1 and 2-2.)

m. Attenuation at Selected Cutoff Frequency:

1. With constant amplitude (CA) response characteristic, attenuation down 0.5 Db ±0.5 Db.

2. With constant delay (CD) response characteristic, attenuation down 3.0 Db ±0.5 Db.

n. Harmonic Distortion: Not greater than 1.0% RMS of full bandwidth at any data frequency up to the channel cutoff frequency with a deviation ratio of 5 or more. Not greater than 1.5% RMS for a deviation ratio of 2.

o. Noise: Not greater than ±0.2% of bandwidth for frequency bands A, B, C, and D. (See specification a.) Not greater than ±0.3% of bandwidth for frequency band E.

p. Nonlinearity: Not greater than ±0.05% best straight line for all deviations.

q. Tape-Speed Compensation: Wow and flutter improvement not less than 20 Db for variations as great as ±3% and

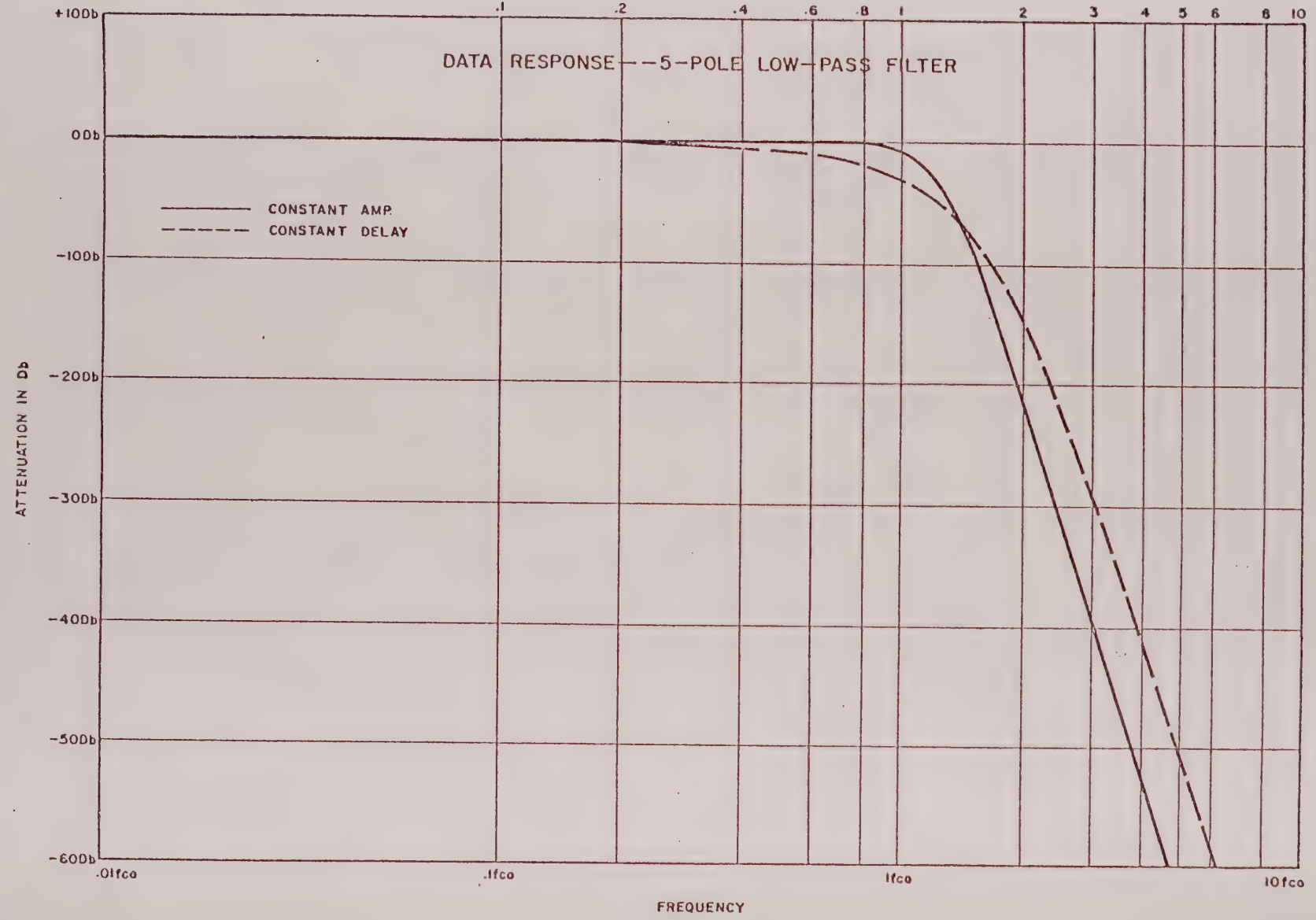


Figure 2-1. Model 4145 Tunable Low-Pass Filter Typical Data Response Curve

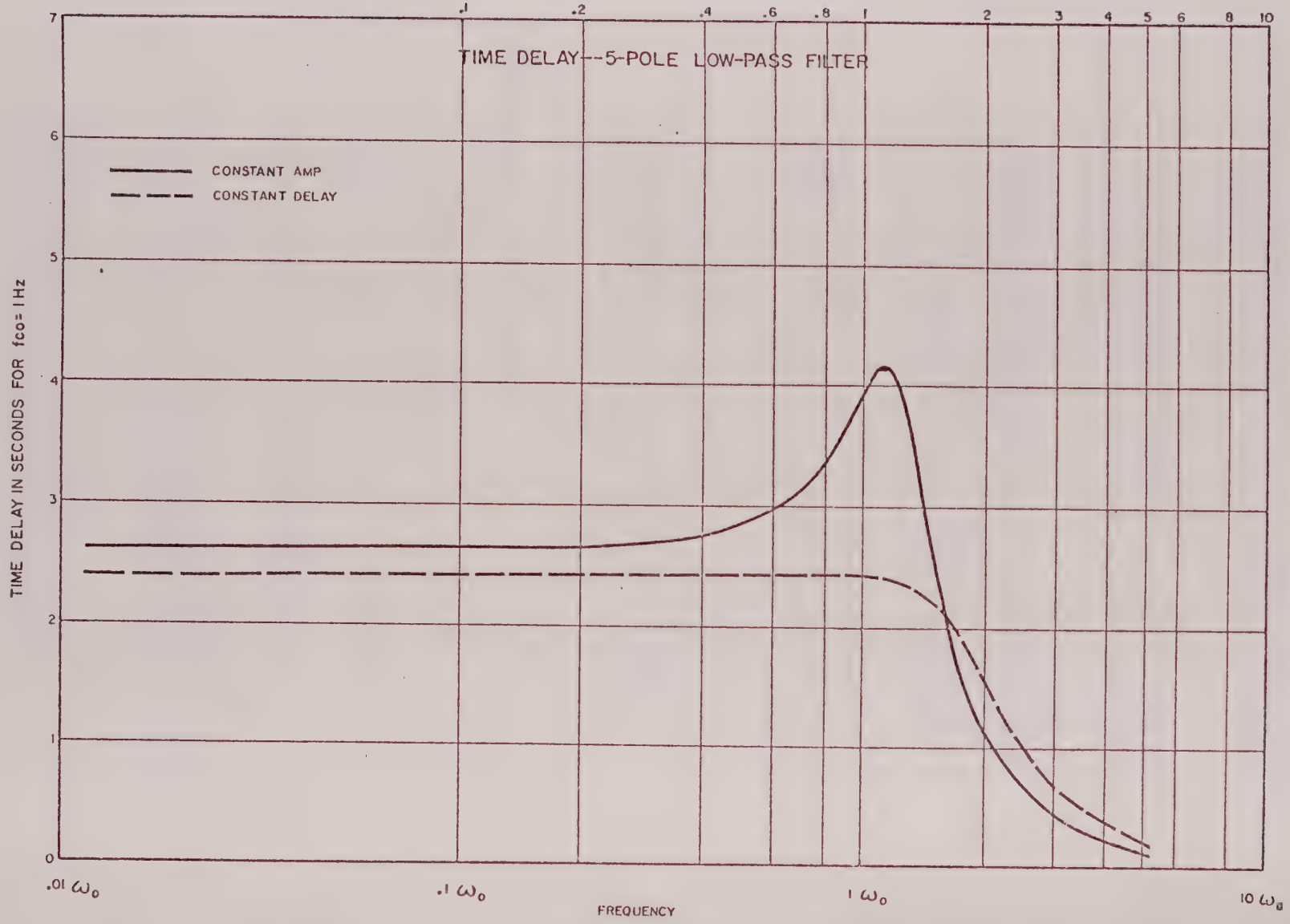


Figure 2-2. Model 4145 Tunable Low-Pass Filter Typical Time Delay Curve

flutter frequencies up to 10 KHz. Tape-Speed compensation input is positive sense with 10 volt peak sensitivity for 7.5% deviation.

r. Deviation Sensitivity Instability: Not greater than ±0.05% of full bandwidth variation (±10 millivolts) in a 15-hour period after a 30-minute warm-up at a constant ambient temperature (±3°C).

s. Adjacent Channel Rejection: Not greater than 0.1% of bandwidth for an interfering signal as great as 20 Db more than the desired signal and located as close as three times the peak deviation from center frequency of desired frequency (for selected band) when output filter is set for a deviation ratio of 2 or more.

t. Line-Voltage Sensitivity: A 10-volt change in line voltage anywhere between 105 and 132 volts causes an error of not more than 0.1% of bandwidth at the discriminator output.

u. Power Requirement: (See Figure 2-3.)

v. Loss of Signal: If selected channel input signal amplitude is less than predetermined level, the output goes to a preset level, adjustable from 0 to ±11 volts.

2.3 MECHANICAL SPECIFICATIONS

a. Panel Size: 5-1/4 inches (13.3 Cm) high by 19 inches (48.2 Cm) wide.

b. Depth: 20 inches (50.8 Cm) excluding projections from front panel.

c. Weight: Net, 55 pounds (25 Kg); shipping, 64 pounds (29.4 Kg).

d. Mounting: May be equipped for slide mounting in a standard 19-inch EIA-type equipment rack. (Refer to Figure 2-3 for various slide mounting configurations.)

e. Paint Finish: Various semi-gloss baking enamel colors and letter combinations are available. (Refer to Figure 2-3 for color information.)

2.4 ENVIRONMENTAL SPECIFICATIONS

a. Orientation: Intended for mounting on a horizontal plane. However, deviation from this plane should not affect the performance.

b. Operating Temperature: +10°C to +50°C, inlet air temperature. Internal cooling is provided by a blower on the rear panel.

c. Storage Temperature: −55°C to +85°C.

d. Barometer Pressure: The unit will function according to specifications up to an effective altitude of 25,000 feet.

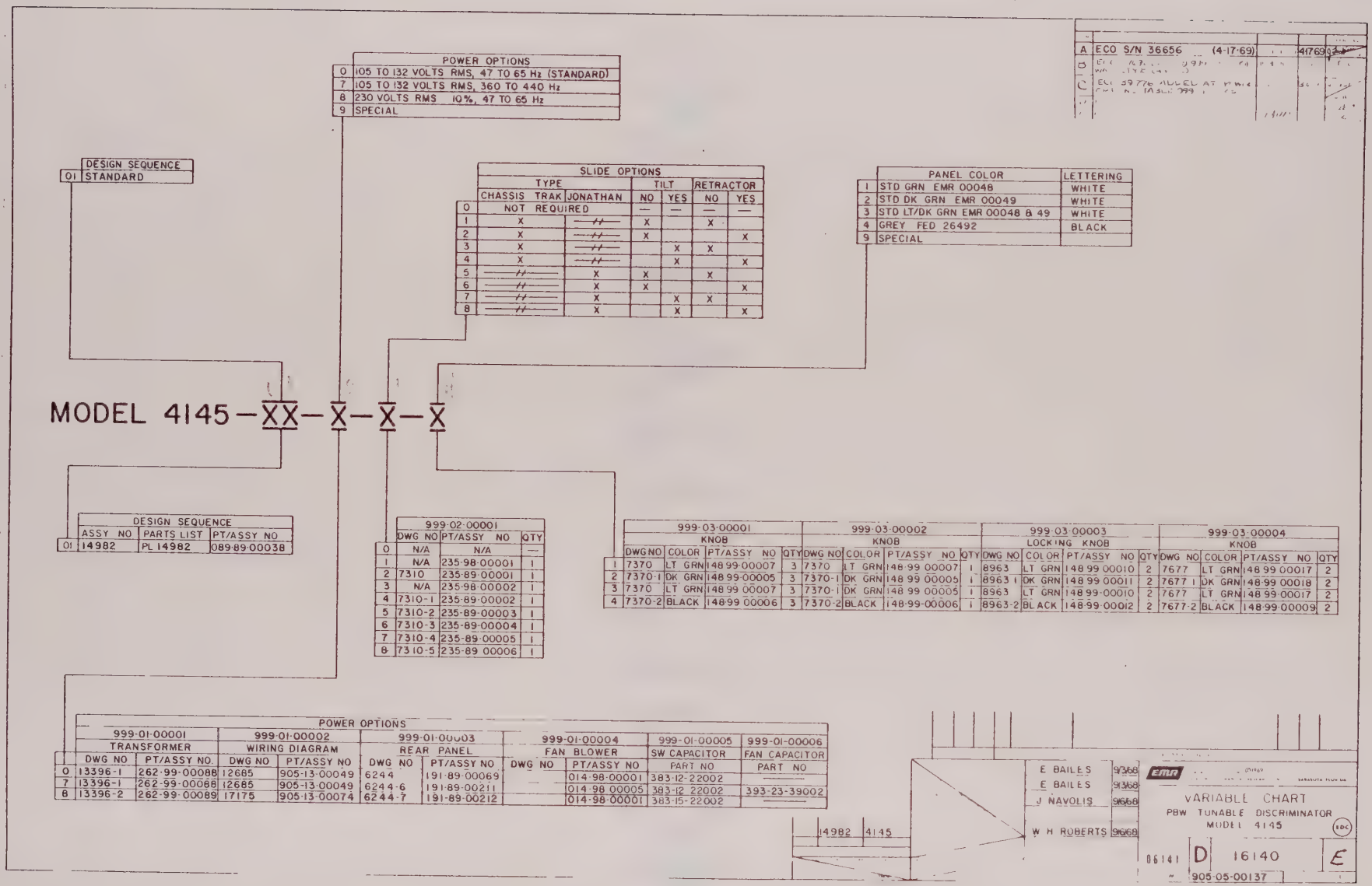


Figure 2-3. Model 4145 Variable Chart

INSTALLATION

SECTION 3

INSTALLATION AND OPERATION

3.1 INSTALLATION

The EMR Model 4145 CBW Tunable Discriminator is shipped completely assembled and ready for installation. The unit is calibrated and adjusted prior to shipment, and all plug-in printed-wiring cards inserted into the appropriate receptacles and all covers are installed. The unit should be inspected immediately on its arrival and notice given to EMR-Telemetry of any claim that the product does not conform with the terms of the order.

The Model 4145 may be ordered with or without mounting slides. (Refer to paragraph 2.3d for the various mounting configurations.) Units without slide mounts may be bolted directly to a standard 19-inch equipment rack with the hardware provided for that purpose. For installation of a Model 4145 with slide mounts, remove the slides from the discriminator after unpacking the unit and mount the slides to the internal frame of the equipment rack. Mounting hardware for this installation is supplied with the discriminator. Insert the discriminator into the slides until the unit is firmly seated. Turn-to-lock fasteners located on either side of the discriminator front panel secure the unit in the rack.

The discriminator may be extended from the equipment rack for servicing by loosening the front-panel turn-to-lock fasteners and pulling the unit straight out. Push-button stop latches, located on the outside surfaces of both slides, hold the unit at the maximum extension. At this point, the discriminator may be removed from the rack by depressing the push-button stop-latches and pulling the unit straight out.

The external electrical connections to the discriminator are terminated at connectors on the rear panel. These connectors and other rear-panel components are illustrated in Figure 3-1 and described in Table 3-1.

3.2 OPERATION

3.2.1 Local Mode of Operation

In the local mode of operation, the operating parameters for the Model 4145 are selected by front- and rear-panel controls. After selecting the desired operating parameters and energizing the unit, operation of the discriminator is fully automatic until a new set of parameters are required. Front panel indicators and test jacks are provided for monitoring discriminator performance. The front panel controls, indicators, and test jacks are identified in Figure 3-2 and described functionally in Table 3-2. Preoperational adjustment procedures and typical operational setup procedures are outlined in the following paragraphs.

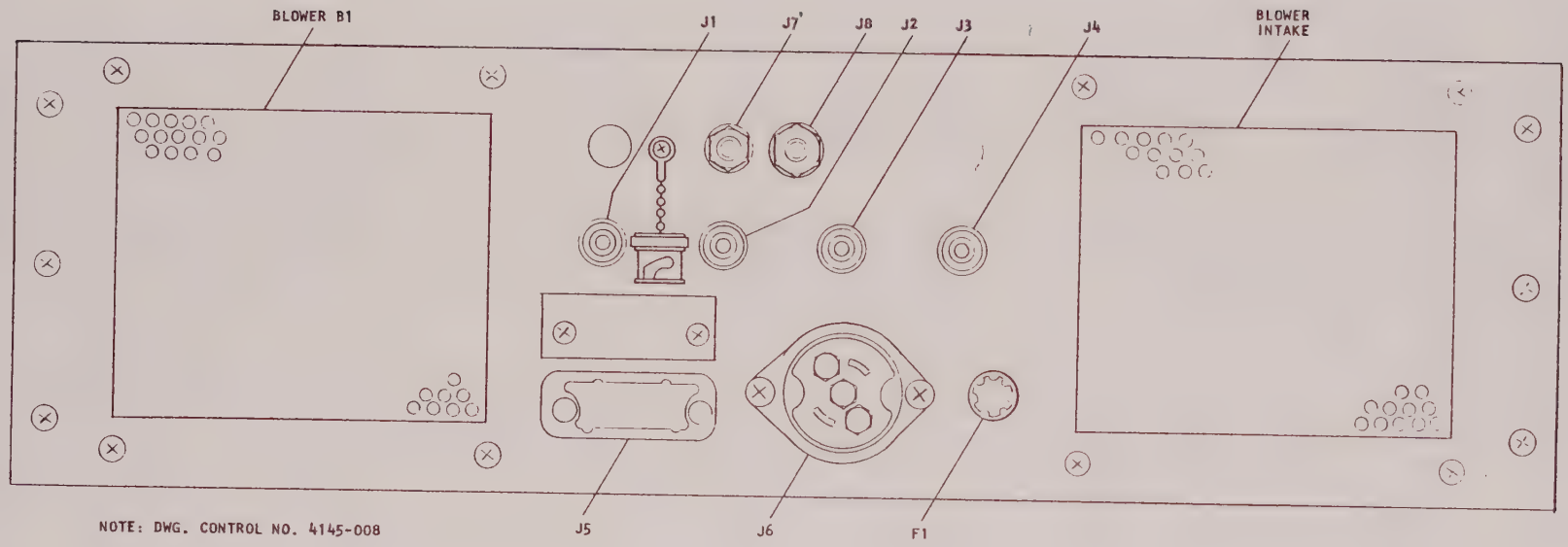


Figure 3-1. Model 4145 CBW Tunable Discriminator Rear-Panel Configuration

Table 3-1. Model 4145 CBW Tunable Discriminator
Function of Rear-Panel Connectors (Ref. Figure 3-1)

DESIG.	NAME	TYPE	FUNCTION
A3J1	OUTPUT	BNC	Discriminator data output.
A3J2	TSC	BNC	Tape-speed-compensation input.
A3J3	INPUT	BNC	FM subcarrier multiplex input.
A3J4	100 KHz	BNC	100 KHz test frequency.
A3J5	REMOTE Control	Amphenol	Used for remotely programming discriminator operating parameters. For pin-function listing and remote-programming instructions, refer to paragraph 3.2.2.
A3J6	POWER Plug	Hubbell Twist-lock	AC power input connection to discriminator power supply.
A3J7	CASE GND	Binding Post	Chassis ground.
A3J8	SIG GND	Binding Post	Signal ground.

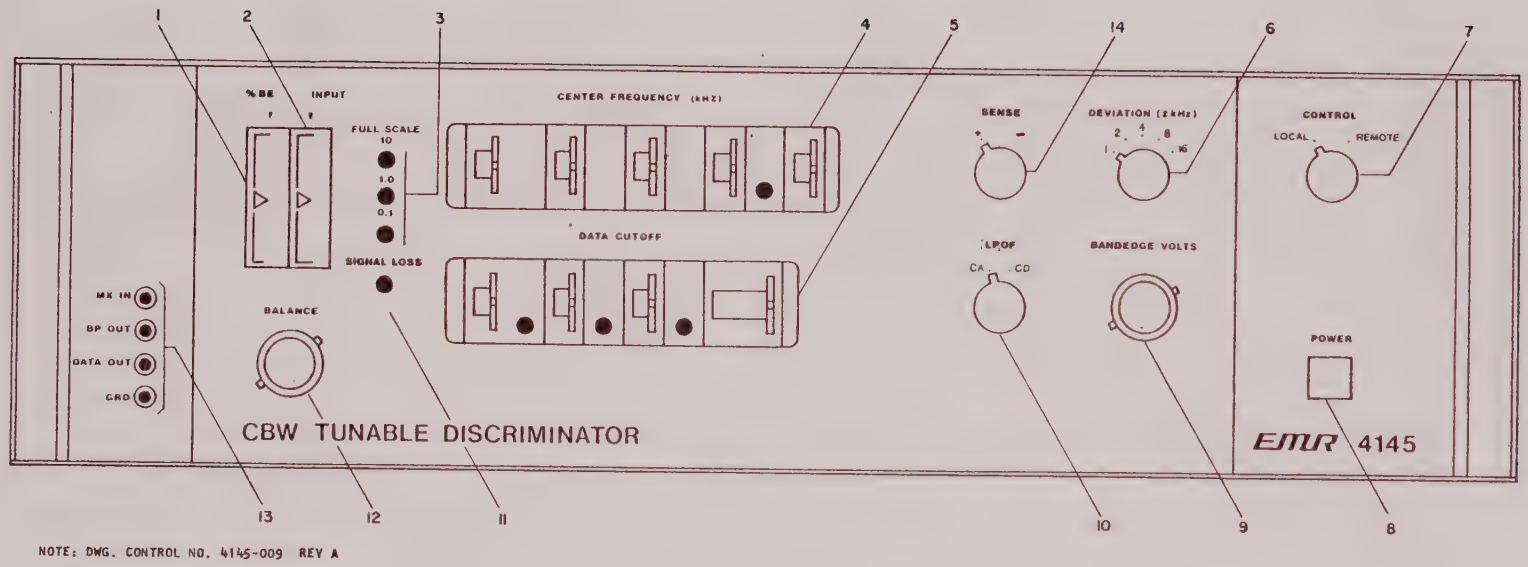


Figure 3-2. Front Panel Assembly A1 Operating Controls, Indicators, and Test Points

Table 3-2. Function of Front Panel Controls and Indicators
(Ref. Figure 3-2)

REF. NO.	NAME	DESIG-NATION	FUNCTION
1	% BE meter	M2	Display percentage of subcarrier signal deviation from center frequency to either bandedge.
2	INPUT meter	M1	Display amplitude of selected subcarrier input signal. Meter control circuitry has automatic range switching feature for displaying full scale readings of 0.1, 1.0, or 10 volts RMS.
3	FULL SCALE 0.1/1.0/10 indicators	DS5, DS6, and DS7	Lamp illuminated indicates full scale range of INPUT meter.
4	CENTER FREQUENCY (kHz) switches	S3 thru S7, and DS1	Five thumbwheel switches which provides for selection of subcarrier center frequencies of 5 KHz to 1600 KHz to five significant digits. Indicator DS1 is a fixed decimal point indicating the tenths of a kilohertz (100 Hz) increments of the subcarrier frequency.
5	DATA CUTOFF (kHz) switches and decimal point indicators	S9 thru S12, and DS2, DS3, and DS4	Three thumbwheel switches provides for selection of a data cutoff frequency of from 10 Hz to 30 KHz. A fourth thumbwheel switch provides for selection, and illumination, of the proper decimal point location to provide a direct readout, significant to three places, for the multiplier.
6	DEVIATION (kHz) switch	S2	Provides for selection of specific frequency band associated with each of five discrete deviation rates as follows: Switch Pos. (Deviation) — Frequency Band 1 — 5 to 100 KHz 2 — 10 to 200 KHz 4 — 20 to 400 KHz 8 — 40 to 800 KHz 16 — 80 to 1600 KHz

Table 3-2 (Cont'd). Function of Front Panel Controls and Indicators (Ref. Figure 3-2)

REF. NO.	NAME	DESIG-NATION	FUNCTION
7	CONTROL LOCAL/ REMOTE switch	S1	Provides for controlling operating parameters of the Model 4145 from either the front panel of the unit (LOCAL) or from an external device (REMOTE) by grounding appropriate input leads at a rear panel connector.
8	POWER push-button switch	S13	Controls application of primary power to the unit. When power is applied, POWER switch is illuminated.
9	BANDEDGE VOLTS potentiometer	R1	Provides for adjustment of data output voltage from ±0.1 to ±10 volts for full bandedge-to-bandedge deviation.
10	LPOF CA/CD switch	S8	Provides for selection of either constant amplitude (CA) or constant delay (CD) output filter response characteristics.
11	SIGNAL LOSS lamp	DS8	Illuminates when subcarrier signal input amplitude is below a preset zero signal threshold. Zero signal threshold is adjustable up to 20 millivolts RMS for frequency bands A, B, and C with a tailored response for bands D and E.
12	BALANCE potentiometer	R2	Provides for adjusting discriminator data output to a zero volt level with a center frequency subcarrier input signal.
13	Test jacks:		
	MX IN	TP4	Multiplex input.
	BP OUT	TP3	Subcarrier signal at output of the second IF bandpass filter
	DATA OUT	TP2	Discriminator data output.
	GRD	TP1	Ground.
14	SENSE switch	S14	Selects the deviation sensitivity (+ or −) of the unit.

3.2.1.1 Initial Checks and Adjustments

Normally the only adjustment required prior to initial operation of the Model 4145 is adjustment of the front panel BANDEDGE VOLTS control. The bandedge voltage adjustment need be made only once and will not change with the selection of another subcarrier channel or selection of another deviation-sensitivity setting. The balance and bandedge voltage adjustments are accomplished as follows:

a. On the rear panel, connect the 100 KHz test signal (connector A3J4) to INPUT connector A3J3, and connect the grounding cap to TSC connector A3J2.

b. Position the front panel controls as follows:

Control	Position
CENTER FREQUENCY (kHz) switches A1S3 thru A1S7	0100.0
CONTROL switch A1S1	LOCAL

c. Depress the front panel POWER push-button switch A1S13.

d. Connect a Fluke Model 825A DC voltmeter to DATA OUT test jack TP2 on the front panel. The DC voltmeter should indicate 0 ±200 millivolts and the front panel BANDEDGE meter, A1M2, should indicate zero deviation.

NOTE

If the center frequency balance indication is abnormal, perform the checkout and adjustment procedures outlined in Section 5. The front panel BALANCE control should only be adjusted to compensate for zero offset when accuracy greater than the specified ±1% of bandwidth is required or, if after a long period of aging, the unit acquires a permanent offset.

e. Position the front panel DEVIATION (±kHz) switch A1S2 to the desired deviation range (1, 2, 4, 8, or 16 KHz)

f. Position the front panel CENTER FREQUENCY (kHz) switches to the frequency at which the 100 KHz test signal represents upper bandedge deviation. For example, if the deviation range of ±4 KHz is selected, position the CENTER FREQUENCY (kHz) switches to 0096.0.

g. Connect the DC voltmeter to DATA OUT test jack TP2 on the front panel and adjust BANDEDGE VOLTS potentiometer A1R1 for the desired bandedge voltage indication (0.1 to 10.0 volts).

3.2.1.2 Typical Operational Setup Procedure

The following procedure is to be used as a guide for setting the operating parameters for the Model 4145:

a. Connect the FM subcarrier multiplex input to the discriminator rear-panel INPUT jack J3.

b. Position the front-panel SENSE switch S14 to negative (−) or positive (+) as required. In the (−) position, an increase in signal-input frequency will result in a negative-going discriminator output voltage. In the (+) position, an increase in signal-input frequency will result in a positive-going discriminator output voltage.

c. Depress the front-panel POWER pushbutton.

d. Position the front-panel CONTROL switch S1 to LOCAL.

e. Position the front-panel DEVIATION (±kHz) switch S2 to the required position.

f. Position the front-panel CENTER FREQUENCY (k Hz) thumbwheel switches to the significant digits of the selected center frequency.

g. Position the front-panel DATA CUTOFF thumbwheel switches to the significant digits of the selected data-cutoff frequency.

h. Position the front-panel LPOF switch S8 to CA or CD as required. (The CA position is recommended for analog-type data outputs and the CD position is recommended for pulse-type data outputs.)

i. Observe that SIGNAL LOSS indicator extinguishes within first 15 minutes of operation.

3.2.2 Remote Mode of Operation

In the remote mode of operation, the discriminator operating parameters are selected by applying external input signals to control lines at the rear-panel remote connector A3J5. These input signals are in the form of ground level (0-volt) inputs at the appropriate pins to select each operating point.

To place the discriminator under remote control, position the front-panel CONTROL switch, S1, to REMOTE. This disables all local controls except the POWER pushbutton switch, the BANDEDGE VOLTS control, and the BALANCE control. The bandedge voltage is adjusted while under local control, and when switching to remote control, this setting will remain constant throughout the entire operating range of the discriminator.

The operating points and program instructions are contained in Table 3-3. The rear-panel remote connector and pin-location diagram is shown in Figure 3-3.

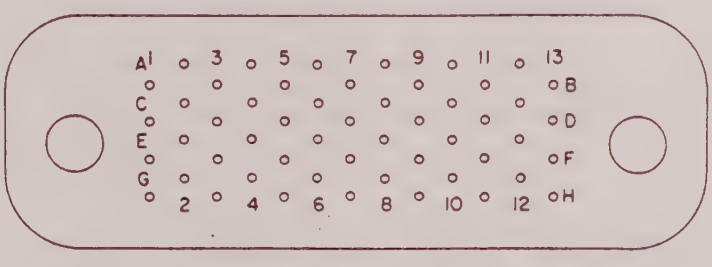
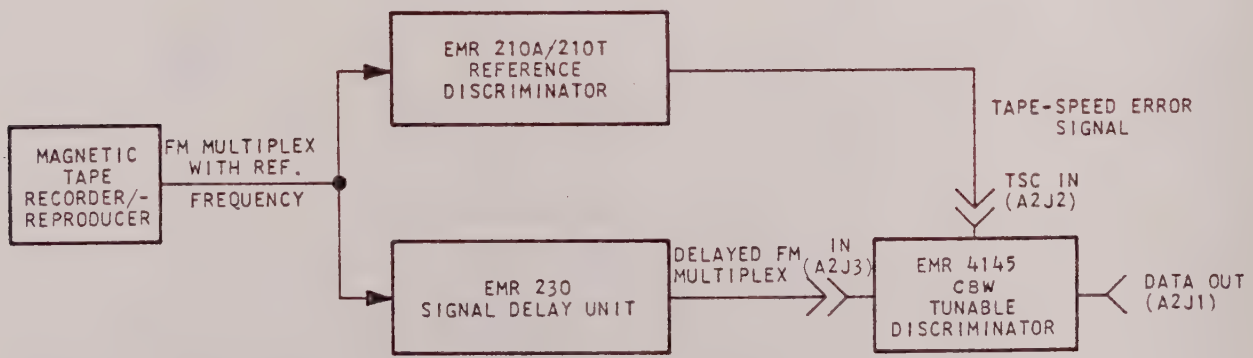


Figure 3-3. Remote Control Connector A3J5 Pin-Location Diagram

3.2.3 Tape-Speed-Compensation (TSC) System

The discriminator may be used in a tape-speed-compensation (TSC) system connected as is shown in Figure 3-4. This system requires a reference discriminator and a signal delay unit to be used in conjunction with the Model 4145 Discriminator.



NOTE: Dwg. Control No. 4145-007.

Figure 3-4. Tape-Speed-Compensation System Block Diagram

Table 3-3. Remote Control Programming Instructions
(Ref. Figure 3-3)

Operating Parameter To Be Selected	Program Instruction (Input At Rear Panel Remote Connector A3J5)
Center Frequency Digits	
Most Significnat Digit Digit 1 (MSD)	
0	Ground Pin G10
1	Pin G10 Open
Digit 2	
0	Ground Pin B1, D1, F1 and H1
1	Ground Pin D1, F1, and H1
2	Ground Pin B1, F1, and H1
3	Ground Pin F1 and H1
4	Ground Pin B1, D1, and H1
5	Ground Pin D1 and H1
6	Ground Pin B1 and H1
7	Ground Pin H1
8	Ground Pin B1, D1, and F1
9	Ground Pin D1 and F1
Digit 3	
0	Ground Pin A2, C2, E2, and G2
1	Ground Pin C2, E2 and G2
2	Ground Pin A2, E2, and G2
3	Ground Pin E2 and G2
4	Ground Pin A2, C2, and G2
5	Ground Pin C2 and G2
6	Ground Pin A2 and G2
7	Ground Pin G2
8	Ground Pin A2, C2, and E2
9	Ground Pin C2 and E2
Digit 4	
0	Ground Pin B3, D3, F3, and H3
1	Ground Pin D3, F3 and H3
2	Ground Pin B3, F3, and H3
3	Ground Pin F3 and H3
4	Ground Pin B3, D3, and H3
5	Ground Pin D3 and H3
6	Ground Pin B3 and H3
7	Ground Pin H3
8	Ground Pin B3, D3, and F3
9	Ground Pin D3 and F3

Table 3-3 (Cont'd.). Remote Control Programming Instructions
(Ref. Figure 3-3)

Operating Parameter To Be Selected	Program Instruction (Input At Rear Panel Remote Connector A3J5)
Center Frequency Digits (Cont'd.)	
Least Significant Digit Digit 5 (LSD)	
0	Ground Pin A4, C4, E4, and G4
1	Ground Pin C4, E4, and G4
2	Ground Pin A4, E4, and G4
3	Ground Pin E4 and G4
4	Ground Pin A4, C4, and G4
5	Ground Pin C4 and G4
6	Ground Pin A4 and G4
7	Ground Pin G4
8	Ground Pin A4, C4, and E4
9	Ground Pin C4 and E4
Deviation Range	
±1	Ground Pin D9, F9, H9, and A10
±2	Ground Pin B9, F9, H9, and A10
±4	Ground Pin B9, D9, H9, and A10
±8	Ground Pin B9, D9, F9, and A10
±16	Ground Pin B9, D9, F9, and H9
Data Cutoff Digits	
MSD = 1	Ground Pin B5
2	Ground Pin D5
3	Ground Pin B5 and D5
4	Ground Pin H5
5	Ground Pin H5 and B5
6	Ground Pin H5 and D5
7	Ground Pin H5, B5, and D5
8	Ground Pin F5
9	Ground Pin F5 and B5
Digit 2 = 1	Ground Pin A6
2	Ground Pin C6
3	Ground Pin A6 and C6
4	Ground Pin E6
5	Ground Pin E6 and A6
6	Ground Pin E6 and C6
7	Ground Pin E6, A6, and C6
8	Ground Pin G6
9	Ground Pin G6 and A6

Table 3-3 (Cont'd). Remote Control Programming Instructions
(Ref. Figure 3-3)

Operating Parameter To Be Selected	Program Instruction (Input At Rear Panel Remote Connector A3J5)
Data Cutoff Digits (Cont'd.)	
LSD = 1	Ground Pin B7
2	Ground Pin D7
3	Ground Pin B7 and D7
4	Ground Pin F7
5	Ground Pin F7 and B7
6	Ground Pin F7 and D7
7	Ground Pin F7, B7, and D7
8	Ground Pin H7
9	Ground Pin H7 and B7
Data Cutoff Multiplier	
10 Hz	Ground Pin A8
100 Hz	Ground Pin C8
1 KHz	Ground Pin E8
10 KHz	Ground Pin G8
Response Characteristic	
CA	Ground Pin C10
CD	Ground Pin E10

In this system, the prerecorded FM multiplex is applied to a reference discriminator and a signal delay unit. The reference discriminator accepts the reference frequency from the FM multiplex and detects any reference frequency modulation incurred during the recording or playback process. Any reference-frequency modulation results in a tape-speed-error signal at the reference discriminator output.

The signal delay unit delays the FM multiplex an amount equal to the delay in the reference discriminator. The delayed FM multiplex and the tape-speed-error signal are then applied to the Model 4145 via connectors A3J3 and A3J2, respectively. A bandpass input filter in the Model 4145 extracts the subcarrier channel from the FM multiplex and an FM detector detects the data in that channel.

If tape-speed variations have occurred, these variations result in erroneous subcarrier modulations and would be detected as data in that subcarrier channel. However, the tape-speed error signal affects tuning of the discriminator in such a way as to compensate for the erroneous modulations and only the true subcarrier channel data is applied to the Model 4145 data output.

If TSC is not used, the TSC input A3J2 must be shorted to ground. A shorting cap is attached to the discriminator rear panel for this purpose.

OPERATION

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section contains the functional theory of operation for the Model 4145 CBW Programmable Tunable Discriminator. The operation of the Model 4145 is described at two levels; a general theory of operation, based on the overall functional block diagram (Figure 4-1) is discussed in paragraph 4.2 and detailed descriptions of individual functions, referenced to applicable detailed functional block diagrams, are provided in paragraph 4.3. The physical/functional relationship of circuits in the Model 4145 is maintained throughout the theory discussions as an aid for troubleshooting the unit. References are provided in each functional block to the applicable schematic diagrams which are provided in Section 5 of this manual.

4.2 GENERAL THEORY OF OPERATION

The Model 4145 accepts an FM multiplex of subcarrier signals in the input frequency range of 5 kHz to 1.6 MHz, extracts a selected subcarrier channel, demodulates the intelligence data from the selected channel by pulse-averaging detection, and presents the intelligence data at the output of the discriminator in the form of a varying analog voltage.

As shown in the overall functional block diagram, Figure 4-1, the Model 4145 is composed of six functional circuit groups. The FM multiplex of subcarrier signals is applied to the input control and metering circuit group which is composed of the input level control and meter range detection circuit, front panel INPUT meter A1M1, and the meter range indicators A1DS5 through A1DS7. The input level control and meter range detection circuit is comprised of circuitry located on printed-wiring cards A2A7 and A2A12. The maximum composite input signal is limited to ±10 volts peak and is buffered by the input control and metering circuits before being applied to the channel selector circuit group. These circuits also detect the level of the selected subcarrier input as being in one of three ranges (less than 0.1 volt, 0.1 to 1.0 volt, or 1.0 to 10 volts) and provide the necessary input attenuation for switching meter range scales. The specific range being displayed on the front panel INPUT meter is identified by front panel meter range indicators. The input control and metering circuit group also contains circuitry which monitors for amplitude levels of the selected subcarrier input below a preset minimum level. If the amplitude of the selected subcarrier channel falls below the preset level, a zero signal command is generated. This command clamps the data output at some preset voltage between −11V and +11V.

The digital control circuit group and the frequency synthesizer circuit group provide the circuitry for automatically tuning the Model 4145 to a selected subcarrier center frequency. The digital control circuit group is composed of a BCD counter and comparator circuit, card A2A3; a binary counter, storage,

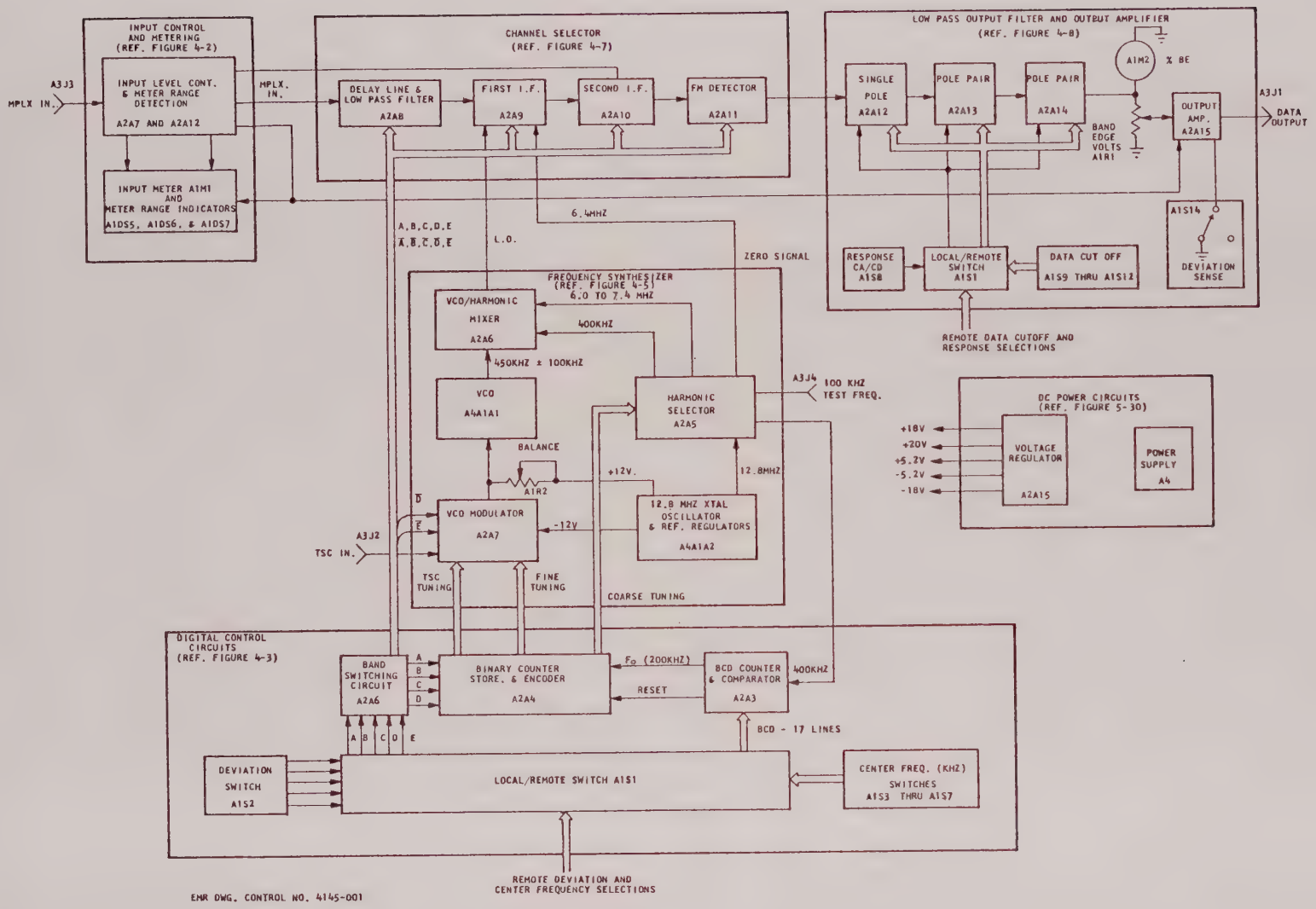


Figure 4-1. Model 4145 CBW Tunable Discriminator Overall Functional Block Diagram

and encoder circuit, card A2A4; a band switching circuit, part of card A2A6; the front panel DEVIATION switch A1S2, and CENTER FREQUENCY (kHz) switches A1S3 through A1S7. The five center frequency switches each provide a BCD input to comparator stages on card A2A3, representative of the center frequency value. Card A2A3 also contains a five digit BCD counter which is incremented at a 200 KHz rate by pulses derived from the 12.8 MHz crystal oscillator (A4A1A2). The 200 KHz counter-input pulses are also coupled to the input of a 14-stage binary counter on card A2A4. Thus both the BCD counter and the binary counter are incremented by common input pulses. When the BCD counter value is equal to the BCD value furnished from the CENTER FREQUENCY (kHz) switches, the comparator circuit on card A2A3 produces a reset pulse. This pulse resets both the BCD and binary counters and also transfers the 12 most significant bits of the binary count to a storage register. The 8 least-significant-bits of the stored binary count are applied to card A2A7 as fine tuning inputs and the 8 most-significant-bits of the stored count are applied to A2A7 as tape speed compensation inputs. The four most-significant-bits of the stored binary count are also applied to an encoder circuit on card A2A4 which provides fifteen coarse tuning lines to the harmonic selector, card A2A5. Only one coarse tuning line is active for any selected center frequency.

The front panel DEVIATION switch A1S2 selects one of five frequency bands as follows:

Deviation (±kHz)	Frequency Band	Frequency Range (kHz)
1	A	5 to 100
2	B	10 to 200
4	C	20 to 400
8	D	40 to 800
16	E	80 to 1600

The band switching circuit on card A2A6 provides control inputs derived from the setting of switch A1S2 to the channel selector functional group and to the VCO modulator circuit, card A2A7, in the frequency synthesizer circuit group.

In addition to the VCO modulator circuit, the frequency synthesizer circuit group is composed of a VCO (card A4A1A1), a 12.8 MHz crystal oscillator (card A4A1A2), the harmonic selector circuit (card A2A5), and the VCO/harmonic mixer circuit (card A2A6). The 12.8 MHz crystal oscillator provides a very stable frequency source for the coarse tuning function initiated by the harmonic selector circuit. The harmonic selector, under control of the coarse tuning input, produces an output frequency at one of the fifteen 102.4 KHz incremental steps between 6.04 MHz and 7.47 MHz. The harmonic selector also produces fixed frequencies of 6.4 MHz, 400 KHz, and 100 KHz each of which is derived from the 12.8 MHz crystal oscillator frequency by binary division.

The VCO modulator circuit provides the modulation signal input for the voltage-controlled oscillator on card A4A1A1 in the oven assembly. The modulation

signal is derived from the sum of analog voltages produced by a fine tuning ladder circuit and a tape speed compensation ladder circuit and is capable of varying the 450 KHz center frequency of the VCO plus or minus 100 KHz. This range allows ±50 KHz each for fine tuning and tape speed compensation. The resultant VCO output is applied to the VCO/harmonic mixer circuit where, through a series of mixing operations, a local oscillator (LO) output signal is generated. This signal, which is coupled to the first IF stage in the channel selector circuit group, represents the coarse tuning, fine tuning, and tape speed compensation requirements for extracting the desired subcarrier channel from the FM multiplex input.

The channel selector circuit group consists of the circuitry contained on four plug-in printed-wiring cards; delay line and low pass filter card A2A8, first IF card A2A9, second IF card A2A10, and detector card A2A11. The FM multiplex output of the input control and metering functional circuit group is applied to delay line and low pass card A2A8. The low pass filter circuit is composed of five band switchable filters which serve to improve the signal-to-noise ratio of associated frequency bands and a tapped delay line. Filter selection is controlled by the front panel DEVIATION switch, A1S2. The selected low pass filter and associated segment of the tapped delay line delays the selected band of FM multiplex (with tape speed errors) for a period equal to the filter delays encountered by the tape speed error compensation signal in the frequency synthesizer group.

The FM multiplex output of the selected filter on card A2A8 is applied to first IF card A2A9 where it is mixed with the appropriate band-controlled sub-multiple of the local oscillator signal. The difference frequency output of the first multiplex mixer on card A2A9 passes through one of five band-switchable bandpass filters and mixes with an appropriate sub-multiple of the 6.4 MHz input from the frequency synthesizer circuit group. The output of the second mixer stage on card A2A9, which contains the intelligence data of the selected center frequency, passes through one of five band-switchable bandpass filters on the second IF card, A2A10. Each of these linear phase filters has a bandwidth of 12.5% and the center frequencies range from 16 KHz to 256 KHz for bands A through E. The second IF card output is applied to the FM detector card, A2A11. The FM detector circuit processes the sine wave intelligence data input and provides a one shot input to the low pass output filter and output amplifier circuit group. This one shot output establishes precise amplitude levels for the detected subcarrier signal.

The low pass output filter and output amplifier circuit group is composed of a 5-pole low pass filter (cards A2A12, A2A13, and A2A14) and an output amplifier circuit located on card A2A15. The five-pole low pass filter is tunable to within three significant digits over a range of 10 Hz to 30 KHz by means of the front panel DATA CUTOFF switches A1S9 through A1S12. The front panel LPOF switch, A1S8 allows for selection of either constant amplitude or constant delay output response characteristics. The filtered output of card A2A14 is coupled through BANDEDGE VOLTS control A1R1 and the output amplifier circuit to

rear panel connector A3J1. The output amplifier provides the current and voltage drive capability for output recording and readout devices. The discriminator output voltage is adjusted for bandedge deviation of a selected subcarrier channel by the BANDEDGE VOLTS control. The front panel % BE meter, A1M2, displays a relative indication of the magnitude and direction of the subcarrier deviation.

The DC power circuits group provides the primary DC operating voltages for the Model 4145 discriminator. The DC power circuits consist of power supply assembly A4; the +18 volt, +20 volt, +5.2 volt, −5.2 volt, and −18 volt regulators located on card A2A15.

4.3 DETAILED THEORY OF OPERATION

The following paragraphs provide detailed descriptions of the functional circuit groups identified in paragraph 4.2.

4.3.1 Input Control and Metering Circuit Group (Ref. Figure 4-2)

The amplitude of the FM multiplex input to the Model 4145 may vary over the range of 10 millivolts to 5 volts RMS. Therefore, it is necessary to incorporate dynamic compression at the input to prevent overload in the mixer stages of the channel selector circuit group. This is accomplished by automatic level adjust circuitry which monitors the input signal amplitude and inserts or removes fixed attenuation when the input amplitude is above or below preset levels. The input control and metering circuit group also contains circuitry which generates commands for activating a specific meter range indicator on the front panel. These indicators identify the full scale amplitude of the front panel INPUT meter, A1M1, and will change automatically as the input control circuits detect changes in the input level.

The FM multiplex input to the Model 4145 is routed from rear panel connector A3J3 to pin 1 on level adjust and VCO modulator card A2A7. The multiplex input is limited at ±18 volts by normally reverse biased diodes CR4 and CR5, buffered by emitter followers Q1 and Q6, and is coupled to the insertion loss network composed of diode bridge CR13 through CR16 and resistor R5, and to the amplifier circuit consisting of transistors Q7, Q8, and Q9. The amplifier output is coupled through potentiometer R64 and applied to a greater-than-1.0-volt Schmitt trigger circuit consisting of transistors Q10 through Q13. The Schmitt trigger and inverter Q14 provide the control inputs for the insertion loss network. When the amplitude of the multiplex input is less than 1.0 volt, the output levels produced by the Schmitt trigger and inverter Q14 forward bias diode bridge CR13 through CR16. Thus the bridge is effectively a short circuit to the input multiplex, allowing the input to be coupled unattenuated to buffer amplifier Q2. If the input amplitude becomes greater than 1.0 volt, the output levels of the Schmitt trigger and inverter Q14 change state thereby reverse biasing the diode bridge. When the bridge is reverse biased, a 20 Db attenuation, resistor R5, is inserted in the path of the input signal flow to

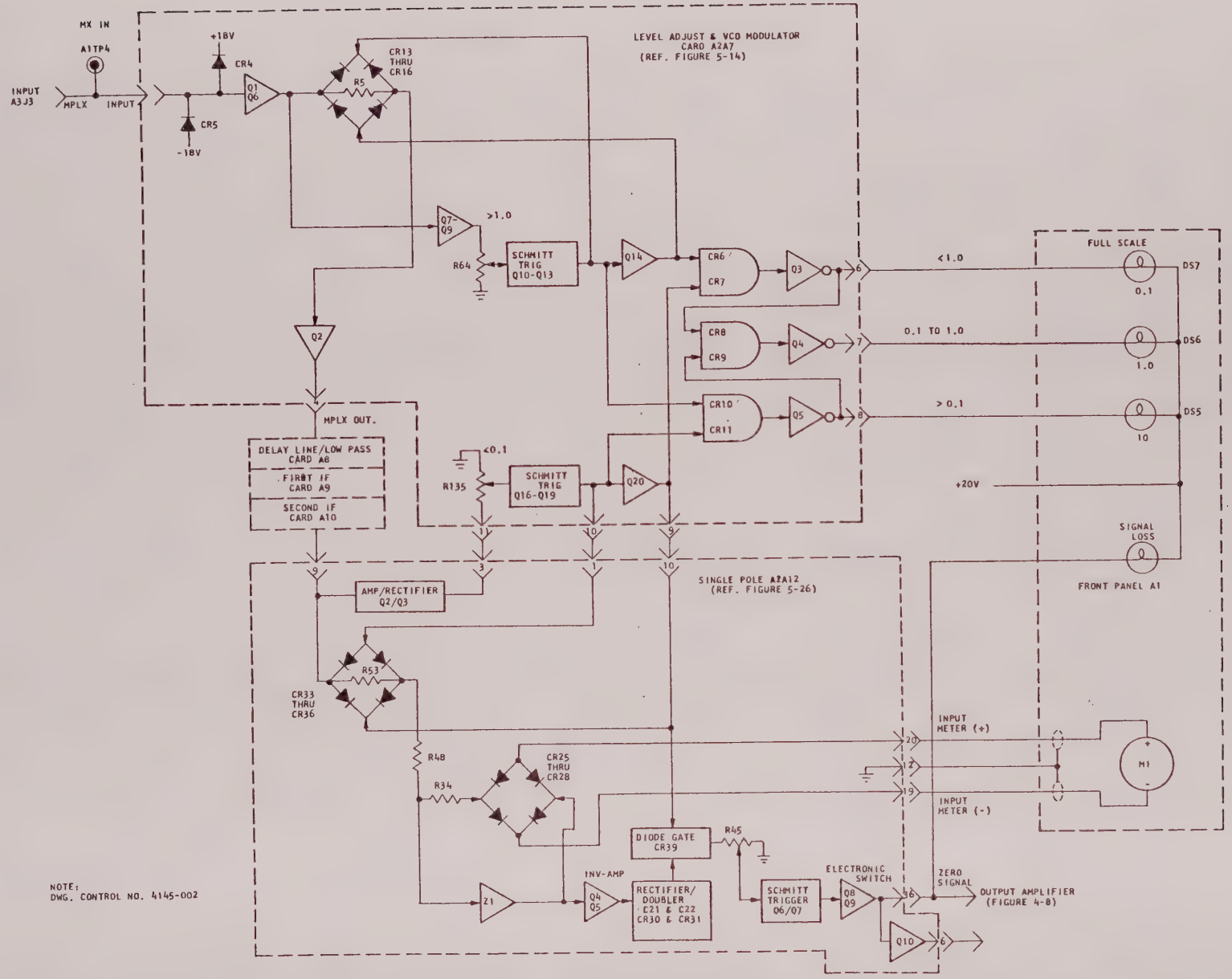


Figure 4-2. Input Control and Metering Circuit Group Functional Block Diagram

buffer Q2. Potentiometer R64 controls the triggering level for the greater-than-1.0-volt Schmitt trigger.

The FM multiplex output of buffer amplifier Q2 is coupled from pin 4 on card A2A7 to delay line/low-pass card A2A8, part of the channel selector functional circuit group. The subcarrier channel extracted from the FM multiplex by the channel selector is coupled from second IF card A2A10 to pin 9 of single-pole card A2A12. The selected subcarrier channel signal is routed to an insertion loss network, composed of diode bridge CR33 through CR36 and resistor R5 and, after conversion to DC by rectifier Q2/Q3, to the less-than-0.1-volt Schmitt trigger on card A2A7. This Schmitt trigger and insertion loss network functions the same as that previously described for greater-than-1.0-volt input amplitudes. However, for signal amplitudes of less than 0.1 volt, the Schmitt trigger consisting of transistors Q16 through Q19 on card A2A7 is turned off and the bridge is effectively a short circuit to signal flow. If the signal amplitude is greater than 0.1 volt, the Schmitt trigger is turned on causing the bridge to be reverse biased, thus inserting a 20 Db loss, resistor A2A12R53, in the signal flow path. Potentiometer A2A7R135 controls the triggering point for the less-than-0.1-volt Schmitt trigger.

A meter indication of the input level is obtained by monitoring the signal amplitude applied across full-wave bridge CR25 through CR28 on card A2A12. Each 20 Db loss insertion or removal resets the front panel INPUT meter to zero and changes the conditioning levels applied to the meter range decoder circuit. The decoder circuit, composed of diode gates CR6/CR7, CR8/CR9, and CR10/CR11, and inverters Q3 through Q5, identifies the range of the input signal amplitude and provides a 0 volt return to the appropriate FULL SCALE indicator on the front panel.

The input control and metering circuit group also contains a zero signal detection network composed of the following circuits located on single-pole card A2A12; inverter-amplifier Q4/Q5, voltage doubler/rectifier C21/C22 and CR30/CR31, diode gate CR39, Schmitt trigger Q6/Q7, and electronic switch Q8/Q9. The function of this network is to provide a command to the output amplifier circuit (reference paragraph 4.3.5) which causes the data output signal to be clamped at a preset level (+11 volts to −11 volts) whenever the input signal amplitude falls below a predetermined value. The output of the electronic switch, Q8/Q9, presents an open circuit to the DC return for relay K1 on card A2A15 (see Figure 4-8) whenever the input signal is greater than 0.1 volts. This is accomplished by diode gate CR39 which inhibits the triggering of Schmitt trigger Q6/Q7 whenever the input signal amplitude is greater than 0.1 volts. When an input signal amplitude of less than 0.1 volts is detected, the output of inverter A2A7-Q20 changes state and diode gate CR39 is reverse biased. When this condition exists, the input signal is coupled from amplifier Z1 through inverter/amplifier Q4/Q5 and a rectifier/voltage doubler circuit to zero-signal-adjust potentiometer A2A12-R45. Potentiometer R45 is adjusted to trigger the Schmitt if the input amplitude falls below a predetermined level. If the Schmitt circuit is triggered, the electronic switch changes state thus providing a DC return for zero signal relay K1 on card A2A15 and for the front panel SIGNAL LOSS indicator, A1DS8.

4.3.2 Digital Control Circuit Group (Ref. Figure 4-3)

The function of the digital control circuit group is to provide command inputs for the frequency synthesizer and channel selector circuit groups, which enables selection of a specific subcarrier channel from the FM multiplex input. This circuit group is composed of BCD converter card A2A3, binary counter card A2A4, the band switching circuits on VCO and harmonic mixer card A2A6, and the DEVIATION (±kHz) switch and CENTER FREQUENCY (kHz) switches located on the front panel. The following paragraphs describe the operation of the digital control circuits on each card.

4.3.2.1 BCD Converter Card A2A3

A 400 KHz square wave, which is produced in the tuning control circuit group from a 12.8 MHz crystal oscillator source, is applied to pin 36 of card A2A3. This signal is inverted by NAND gate Z23-2, divided by flip-flop Z25 to provide a 200 KHz clock rate, inverted by NAND gate Z24-4, and applied to the input of a five digit BCD counter. The BCD counter is composed of flip-flop stages Z3 through Z19 and is capable of a maximum count of 19999. The output of each counter stage is applied to an associated comparator stage (Z1, Z2, Z21, Z22, and Z23-1). Also, applied to the comparators are the BCD equivalents of the decimal numbers selected on front panel CENTER FREQUENCY (kHz) switches A1S3 through A1S7. When the bit value in each counter stage compares with the corresponding bit value provided by the CENTER FREQUENCY (kHz) switches, NAND gate Z20 is enabled. The next positive transition of the 200 KHz clock causes the normally logic ONE output of Z20 to fall to a logic ZERO level, which in turn drives the output of NAND gate Z23-4 to logic ONE state. (Refer to BCD counter timing diagram, Figure 4-4.) The resultant logic ONE coincidence of the inputs to NAND gate Z24-1 (output of Z23-4 and positive transition of 400 KHz clock) produces a negative going transition at the output which provides the reset trigger for the flip-flop stages of the units, tens, and ten thousands digits of the BCD counter. The reset trigger for the hundreds and thousands stages of the BCD counter is provided by inverting the output of Z23-4 through NAND gate Z23-3. The output of Z23-4 (reset pulse) is also routed from pin 35 of card A2A3 to pin 24 of card A2A4, and is inverted through NAND gates Z24-2 and Z24-3 ($\overline{\text{reset}}$ pulse) before being routed from pin A2A3-33 to pin A2A4-14. The $\overline{\text{reset}}$ pulse provides the reset and storage commands for the binary counter and storage circuits on card A2A3.

4.3.2.2 Band Switching Circuits (Card A2A6)

The band switching circuits are composed of front panel DEVIATION (±kHz) switch A1S2 and relay control gates Q6 through Q10, relays K1 through K5, and diode OR gate 1 through 4 (CR7 through CR16), all of which are located on VCO and harmonic mixer card A2A6. The band switching circuits enable operator selection of any one of five frequency bands, each of which is associated with a discrete peak deviation. For convenience, the five bands are

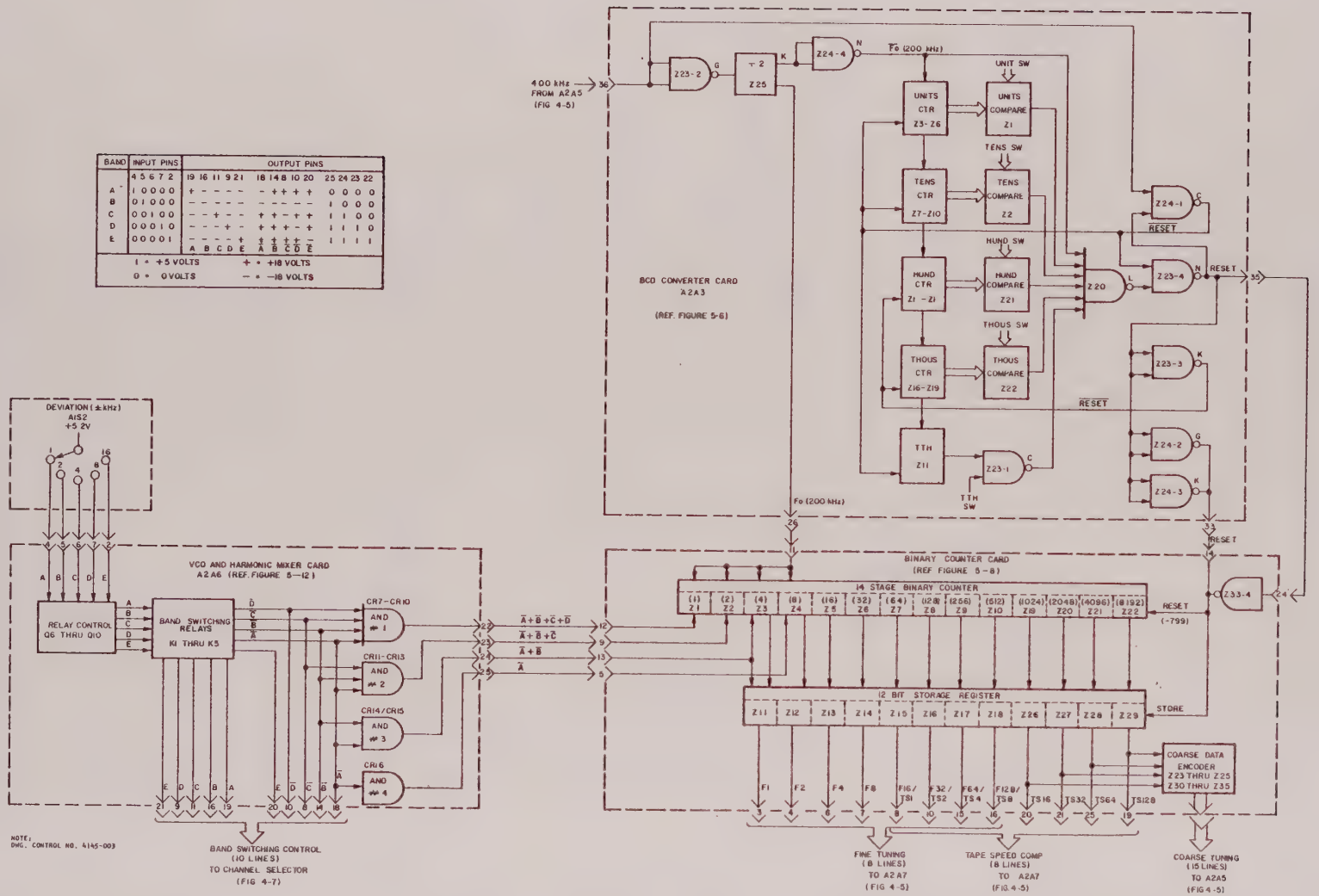


Figure 4-3. Digital Control Circuit Group Functional Block Diagram

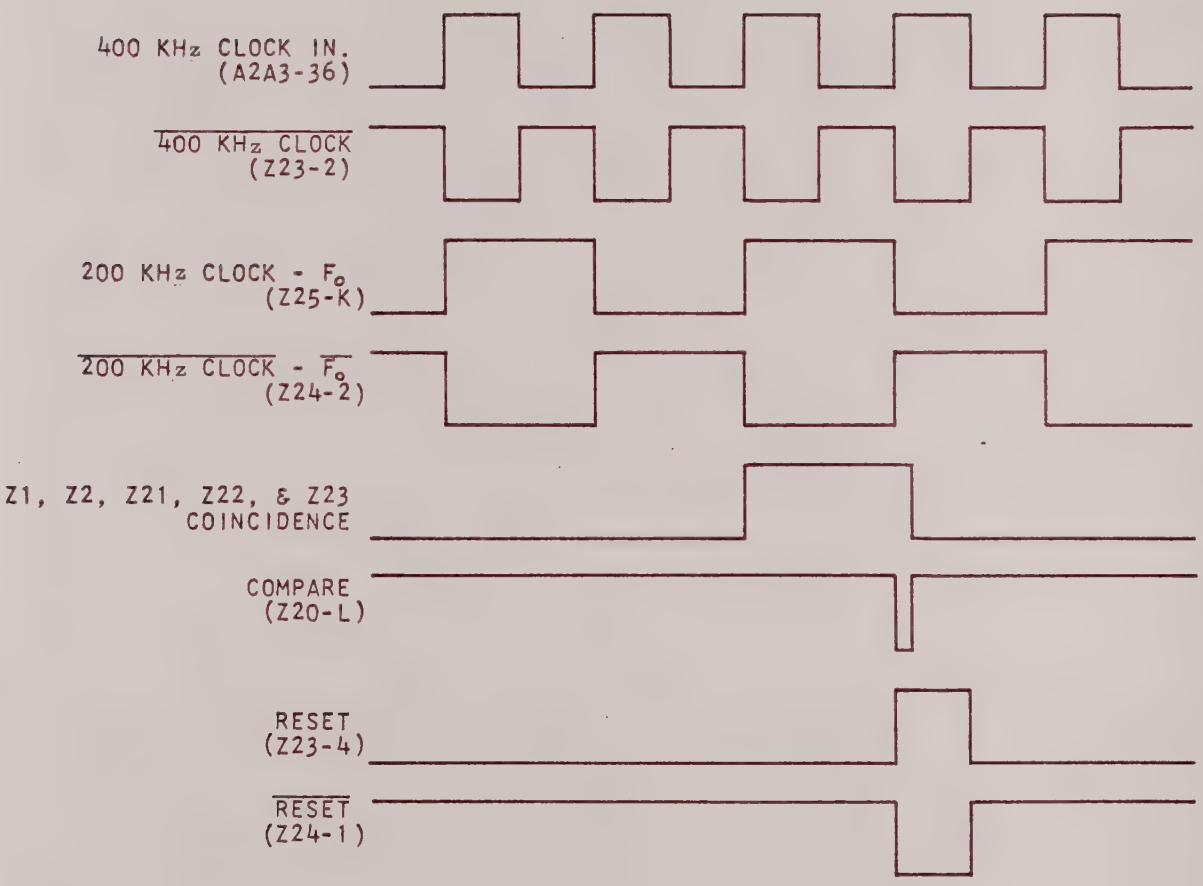


Figure 4-4. BCD Converter Timing Diagram

designated A, B, C, D, and E in this manual. The relationship of the band designator, deviation, and frequency range is identified as follows:

Band	Deviation (kHz)	Frequency Range
A	±1	5 to 100 KHz
B	±2	10 to 200 KHz
C	±4	20 to 400 KHz
D	±8	40 to 800 KHz
E	±16	80 to 1600 KHz

A comparison of the deviation and of the frequency range from one band to another shows a binary relationship. This relationship is the basis of the tuning operations in the Model 4145.

The front panel DEVIATION (±kHz) switch, A1S2, applies a +5.2 volt trigger to one of five relay control gates, Q6 through Q10, on card A2A6. The selected control gate allows its associated relay to be energized. The selected relay provides a +18 volt true output and a −18 volt $\overline{\text{true}}$ output, whereas the true and $\overline{\text{true}}$ outputs of the non-selected relays are −18 volts and +18 volts, respectively. The ten band switching command outputs are routed to the channel selector circuit group. The $\overline{D}$ and $\overline{E}$ command lines are also routed to the VCO modulator circuit on card A2A7 to perform specific control function whenever bands D or E are selected. Diode AND gates 1 through 4 monitor the false outputs of the switching relays associated with bands A through D, and provide inhibit levels to appropriate stages of the binary counter if band A through D is selected. This function is discussed in more detail in the following paragraph.

4.3.2.3 Binary Counter Card A2A4

The binary counter card A2A4 is composed of a 14-stage binary counter (Z1 to Z10 and Z19 to Z22), a 12-stage storage register (Z11 to Z18 and Z26 to Z29), and a coarse data encoder (Z23 to Z25 and Z30 to Z35). While the BCD counter is advancing to the value programmed on the front panel CENTER FREQUENCY (kHz) switches, the binary counter is being incremented by the same 200 KHz clock rate. The clock pulses are applied to pin 11 of card A2A4 and routed to the four least significant stages of the binary counter. The first stage of the counter triggered by the clock pulses is determined by the band switching control circuit. When band E is selected (switch A1S2 set to 16), all 14 stages of the binary counter are incremented sequentially. When switch A1S2 is set to position 8 (band D selected), the normally +18 volt $\overline{D}$ input to AND gate 1 in the band switching circuit is switched to −18 volts. As a result, the output of AND gate 1 is switched from a +5.2 volt enable level to a −1.8 volt inhibit command which inhibits operation of the least significant stage (Z1) in the binary counter. The clock pulses then trigger the second stage of the binary counter. Thus in band D, the binary counter is incremented at twice the rate of band E. The band switching command inputs to the binary counter are such that when band C is selected the counter is incremented at four times the rate of band E,

for band B the counter is incremented at eight times the rate of band E, and for band A the counter value is incremented at 16 times the rate of band E. Thus, the representative binary count for the minimum frequency and maximum frequency in each band is the same.

The reset and $\overline{\text{reset}}$ pulses generated on the BCD converter card (reference paragraph 4.3.2.1) are applied to pins 24 and 14, respectively, on card A2A4. These pulses cause the binary value accumulated in the counter to be loaded into a 12-bit storage register composed of flip-flop stages Z11 through Z18 and Z26 through Z29. The reset pulses also preset the binary counter to a value of 15,884. This is accomplished since it is desired to have a binary value of zero in the counter for the minimum frequency in each band. Thus for band E operation, with the minimum center frequency (80.0 KHz) selected, 800 clock pulse inputs to the BCD counter are required to obtain a comparison. The 15,884 preset value in the binary counter is 799 less than the saturation count of 16,383 and therefore, 800 clock pulses will increment the counter to a zero output value. Since a binary relationship exists between each band of frequencies, the values presented above for band E operation are divided by two for each successively lower band.

The twelve binary bits loaded into the storage register by the reset pulse provide a binary representation of the selected center frequency. These bit values are used to perform three separate functions. The eight least significant bits of stored data, binarily designated F1 through F128, are routed to the fine tuning ladder circuit on level adjust and VCO modulator card A2A7 as fine tuning control lines. The eight most significant bits of the binary count, binarily designated TSC1 through TSC128, are applied to the tape speed compensation ladder circuit on card A2A7. The four most significant bits are also applied to a coarse data encoder circuit composed of NAND gates Z23 through Z25 and Z31 through Z32. The four binary input bit values to the encoder are converted to one of fifteen possible coarse tuning command lines designated C0 through C14. The C0 through C14 command lines, only one of which can be active (zero volt level) at any given time, are applied to the coarse frequency selection circuit on harmonic selector card A2A5.

The relationships between the selected center frequency and the decimal equivalents of the binary values contained in the storage register are shown in Table 4-1 for band E. Note that the coarse value increments every 102.4 KHz, the fine tuning value increments every 0.4 KHz, and the TSC value increments every 6.4 KHz. The coarse, fine, and TSC values repeat for each frequency band, but the represented center frequency for each successively lower band is one half the center frequency of the preceding band. For example, a center frequency selection of 40.2 KHz in band D produces a coarse value of 0, a fine value of 1, and a TSC value of 0, which are the same values produced for a center frequency of 80.4 in band E.

Table 4-1. Center Frequency/Binary Count Relationships

CENTER FREQUENCY	COARSE	FINE	TSC
80.0 kHz	0	0	0
80.1 kHz	0	0	0
80.2 kHz	0	0	0
80.3 kHz	0	0	0
80.4 kHz	0	1	0
80.5 kHz	0	1	0
80.6 kHz	0	1	0
80.7 kHz	0	1	0
80.8 kHz	0	2	0
86.0 kHz	0	15	0
86.1 kHz	0	15	0
86.2 kHz	0	15	0
86.3 kHz	0	15	0
86.4 kHz	0	16	1
182.0 kHz	0	255	15
182.1 kHz	0	255	15
182.2 kHz	0	255	15
182.3 kHz	0	255	15
182.4 kHz	1	0	16
182.5 kHz	1	0	16
182.6 kHz	1	0	16
182.7 kHz	1	0	16
182.8 kHz	1	1	16
1615.2 kHz	14	254	239
1615.3 kHz	14	255	239
1615.4 kHz	14	255	239
1615.5 kHz	14	255	239
1615.6 kHz	14	255	239

4.3.3 Frequency Synthesizer Circuit Group (Ref. Figure 4-5)

4.3.3.1 General

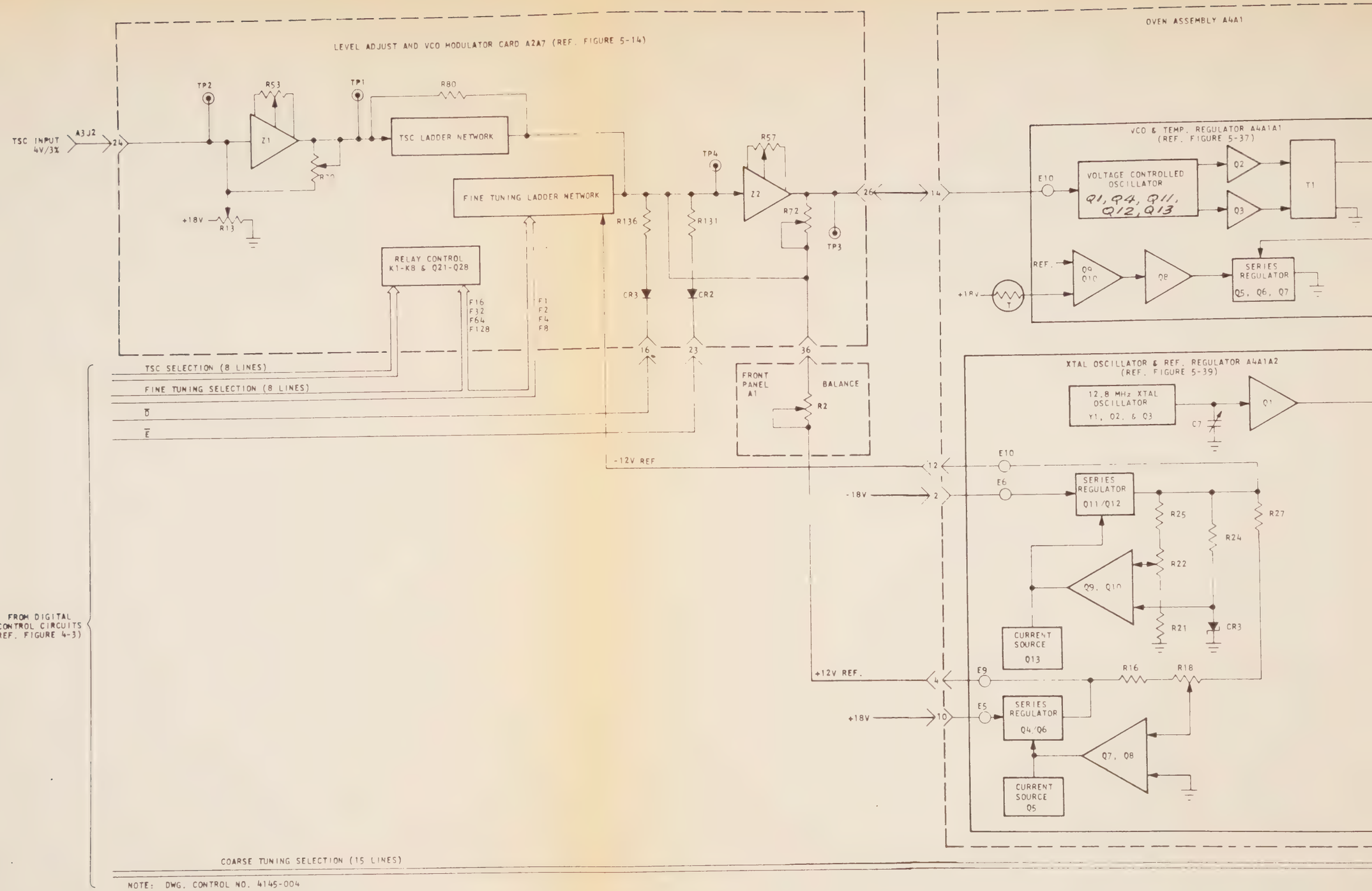
The primary function of the frequency synthesizer circuit group is to produce the local oscillator signals, L.O. and $\overline{\text{L.O.}}$, which tune the channel selector circuit group for the specific subcarrier channel selected on either the front panel or remote control device. The frequency synthesizer also provides precise square-wave outputs of 6.4 MHz, 400 KHz, and 100 KHz, that are used in other functional circuit groups of the Model 4145 and for test purposes. The circuits, which comprise the frequency synthesizer circuit group, are located on crystal oscillator and reference regulator card A4A1A2, harmonic selector card A2A5, level adjust and VCO modulator card A2A7, VCO and temperature regulator card A4A1A1, and VCO and harmonic mixer card A2A6. Individual circuit descriptions are provided for each card in the following paragraphs.

4.3.3.2 Crystal Oscillator and Reference Regulators Card A4A1A2

Card A4A1A2, located in the oven assembly, is composed of a 12.8 MHz crystal oscillator circuit and two reference-voltage regulators, +12 volts and -12 volts. The crystal oscillator circuit is composed of an oscillator (crystal Y1 and transistors Q2 and Q3) and a buffer amplifier, Q1. The oscillator, which provides the basic operating frequency for the frequency synthesizer circuit group, is tuned for precisely 12.8 MHz by variable capacitor C7. Buffer amplifier Q1 serves to isolate the oscillator from the output circuit.

The +12 volt and -12 volt reference regulators provide very stable DC levels for the VCO modulator circuit on card A2A7. Since the operation of both reference regulators is the same, only the operation of the -12 volt regulator is discussed in this paragraph. The -12 volt regulator is composed of a Darlington-connected series regulator (Q11 and Q12), a differential comparison amplifier (Q9 and Q10), and a constant current source (Q13). The source voltage for the -12 volt regulator is the regulated -18 volt output of regulator/output amplifier card A2A15. The -18 volt level is applied to pin 2 of oven assembly A4A1 and routed through terminal A4A1A2-E6 to series regulator Q11 and Q12. Regulation is accomplished by comparing a sample of the output voltage provided by potentiometer R22, with a reference level (-9 volts) established by zener diode CR3. The differential comparison amplifier senses the magnitude and direction of any output voltage change and produces an output that is proportionally equal and opposite to the error detected. The error signal controls the biasing of the Darlington-connected series regulator, thus compensating for the output voltage change. The output of the -12 volt reference regulator is coupled through terminal A4A1A2-E10 and pin A4A1J1-12 to the fine tuning ladder network on card A2A7.

The +18 volt input to the +12 volt reference regulator is regulated in a similar manner. The resultant +12 volt output level is coupled through terminal



NOTE: DWG. CONTROL NO. 4145-004

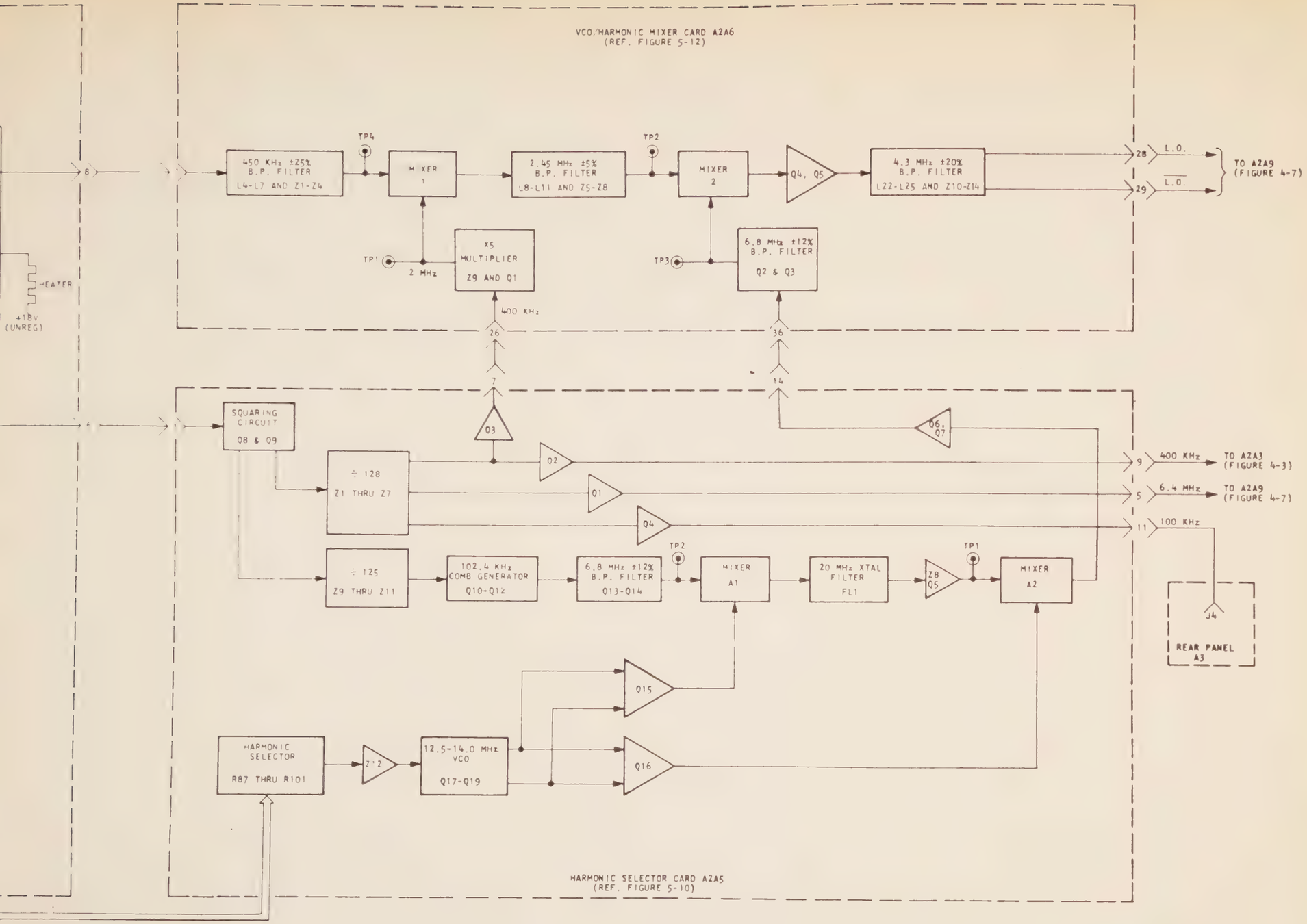


Figure 4-5. Frequency Synthesizer Circuit Group Functional Block Diagram

A4A1A2-E9 and pin A4A1J1-4 to the front panel BALANCE potentiometer A1R2. The 12.8 MHz oscillator and +12 volt and -12 volt reference regulators are mounted in the oven assembly in order to provide the temperature regulation required for extremely stable outputs. Adjustment of the -12 volt regulator does affect the +12 volt supply. The -12 volt supply is a precision setting, whereas the +12 volt supply is normally adjusted so as to center the front panel BALANCE potentiometer. Thus, the +12 volt supply is extremely stable with temperature but its absolute value is only approximately +12 volts.

4.3.3.3 Harmonic Selector Card A2A5

The function of the harmonic selector card is to convert the 12.8 MHz crystal oscillator signal into one of 15 precise frequencies representing the coarse tuning requirement for the selected subcarrier channel. Card A2A5 also provides fixed frequencies of 6.4 MHz, 400 KHz, and 100 KHz, which are used for operational and test purposes in other functional circuits of the Model 4145.

The 12.8 MHz output of the crystal oscillator circuit on card A4A1A2 is received at pin 1 of card A2A5 and applied to a squaring circuit composed of transistor stages Q8 and Q9. The squaring circuit shapes the sine wave input and provides outputs at two different levels; one compatible with the divide-by-128 integrated circuits (Z1 through Z7), and one compatible with the divide-by-125 integrated circuits (Z9 through Z11). The divide-by-125 circuit is composed of three divide-by-five stages which provides a square wave output of 102.4 KHz. This signal is applied to a comb generator (Q10 through Q12) which converts the square wave into pulses recurring at the same 102.4 KHz rate. The Fourier transform of a time-domain pulse is a spectrum of frequencies, each being a multiple of the basic frequency. In this case, the Fourier transform being all harmonics of the 102.4 KHz pulses. The 6.8 MHz ±12% bandpass filter passes the 59th through 73rd harmonic of the 102.4 KHz pulse frequency and applies these 15 frequencies to mixer A1. It is desired that only one of the 15 frequencies be selected. This is accomplished by summing all harmonics of the 102.4 KHz pulse frequency passed by the 6.8 MHz filter with the output of the 12.5 to 14.0 MHz VCO such that the spectrum of frequencies centered about 6.8 MHz at the output of the filter is now centered about 20 MHz at the output of mixer A1. Since the 20 MHz crystal filter FL1 will only pass the one frequency nearest to 20 MHz, it can be seen that by controlling the output of the 12.5 to 14.0 MHz VCO any one of the harmonic frequencies from the bandpass may be translated to 20 MHz and passed by the crystal filter while all others are rejected.

As described in paragraph 4.3.2, 15 coarse data tuning lines, only one of which is active at any given time, are applied to the harmonic selector card. The active line, which represents the coarse tuning requirement for the selected center frequency, is converted to a specific voltage level by the digital-to-analog converter network composed of resistors R87 through R146. This voltage is amplified by operational amplifier Z12 and applied to voltage-controlled oscillator, Q17 and Q19. The oscillator produces one of 15 incremental

frequencies in the range of 12.5 to 14.0 MHz dependent upon the coarse tuning line activated. The resultant VCO frequency is amplified by Q15 and applied to mixer A1.

The 20 MHz output of filter FL1 is amplified and buffered (Z8 and Q5) and applied to mixer A2 where the difference of the 20 MHz and the VCO frequency is taken. This elaborate process of frequency synthesis was required because of the extreme stability required of the coarse tuning signal at output pin 14. Slight drifting of the VCO frequency can be tolerated, as long as the desired up-converted harmonic of the 102.4 pulse frequency remains in the passband of the 20 MHz filter, since any error is cancelled in the down-conversion process.

Relationships between the frequency bands, active coarse tuning line (C number) VCO frequency, and selected harmonic of the 102.4 KHz pulse frequency are identified in Table 4-2. Note that in band E the active C number advances once for every 102.4 KHz increase of center frequency selection on the front panel. Divide by two for each successively lower frequency band.

A second 12.8 MHz output of squaring circuit Q8/Q9 is applied to the divide-by-128 circuit. This circuit is composed of seven divide-by-two integrated circuits (Z1 through Z7). Four binary submultiples of the 12.8 MHz input signal are provided at various points along the divider string. The output of the divider stage, Z1, provides a 6.4 MHz square wave which is coupled through buffer amplifier Q1 and pin A2A5-5 to first IF card A2A9 of the channel selector circuit group. The 400 KHz output of the fifth divider stage, Z5, is routed to two separate functional circuits. One 400 KHz output is coupled through inverter/amplifier Q2 and pin A2A5-9 to BCD counter and converter card A2A3 as the primary clock rate for the digital control circuit group. The second 400 KHz output of divider stage Z5 is coupled through inverter/amplifier Q3 and pin A2A5-7 to VCO and harmonic mixer card A2A6. The final output of the divide-by-128 circuit is the 100 KHz square wave produced by the last divider stage, Z7. This signal, which is within the range of the five frequency bands of the Model 4145, is routed through buffer amplifier Q4 and pin A2A5-11 to rear panel connector A3J4 as a test frequency.

4.3.3.4 Level Adjust and VCO Modulator Card A2A7

Card A2A7 performs two major functions in the operation of the Model 4145; input level adjustment control and modulation control of the 450 KHz voltage-controlled oscillator. Since the circuitry associated with the input level adjustment function was discussed in paragraph 4.3.1, the following circuit description pertains only to the operation of the VCO modulator function.

The VCO modulator circuitry on card A2A7 is composed of amplifier Z1, two digital-to-analog ladder networks, summing amplifier Z2, and a relay control circuit consisting of relays K1 through K8 and transistors Q21 through Q28. The function of the VCO modulator is to provide a voltage input to the 450 KHz VCO which causes the oscillator to produce a frequency output within the range

Table 4-2. Relationships Between Various Parameters On Card A2A5

FREQUENCY BAND					ACTIVE COARSE TUNING LINE		COARSE TUNING VCO FREQ.	SELECTED HARMONIC	HARMONIC OF 102.4 kHz	D/A CONV. TUNING RESISTOR NO.
BAND A	BAND B	BAND C	BAND D	BAND E	C NO.	PIN NO.				
5.0 - 11.3	10.0 - 22.7	20.0 - 45.5	40.0 - 91.1	80.0 - 182.3	0	21	139584	6041.6	59	87
11.4 - 17.7	22.8 - 35.5	45.6 - 71.1	91.2 - 142.3	182.4 - 284.7	1	22	138560	6144.0	60	88
17.8 - 24.1	35.6 - 48.3	71.2 - 96.7	142.4 - 193.5	284.8 - 387.1	2	23	137536	6246.4	61	89
24.2 - 30.5	48.4 - 61.1	96.8 - 122.3	193.6 - 244.7	387.2 - 489.5	3	24	136512	6348.8	62	90
30.6 - 36.9	61.2 - 73.9	122.4 - 147.9	244.8 - 295.9	489.6 - 591.9	4	25	135488	6451.2	63	91
37.0 - 43.3	74.1 - 86.7	148.0 - 173.5	296.0 - 347.1	592.0 - 694.3	5	26	134464	6553.6	64	92
43.4 - 49.7	86.8 - 99.5	173.6 - 199.1	347.2 - 398.3	694.4 - 796.7	6	27	133440	6656.0	65	93
49.8 - 56.1	99.6 - 112.3	199.2 - 224.7	398.4 - 449.5	796.8 - 899.1	7	28	132416	6758.4	66	94
56.2 - 62.5	112.4 - 125.1	224.8 - 250.3	449.6 - 500.7	899.2 - 1001.5	8	29	131392	6860.8	67	95
62.6 - 68.9	125.2 - 137.9	250.4 - 275.9	500.8 - 551.9	1001.6 - 1103.9	9	30	130368	6963.2	68	96
69.0 - 75.3	138.0 - 150.7	276.0 - 301.5	552.0 - 603.1	1104.0 - 1206.3	10	32	129344	7065.6	69	97
75.4 - 81.7	150.8 - 163.5	301.6 - 327.1	603.2 - 654.3	1206.4 - 1308.7	11	33	128320	7168.0	70	98
81.8 - 88.1	163.6 - 176.3	327.2 - 352.7	654.4 - 705.5	1308.8 - 1411.1	12	34	127296	7270.4	71	99
88.2 - 94.5	176.4 - 189.1	352.8 - 378.3	705.6 - 756.7	1411.2 - 1513.5	13	35	126272	7372.8	72	100
94.6 - 100.4	189.2 - 201.9	378.4 - 403.9	756.8 - 807.8	1513.6 - 1615.6	14	36	125248	7475.2	73	101
	ACTIVE LINE INCREMENTS EVERY									
64	12.8	25.6	51.2	102.4						

of approximately 350 KHz to 550 KHz. This range allows ±51 KHz deviation for fine tuning requirements of the selected subcarrier channel and ±48 KHz deviation to compensate for tape speed errors. Fine tuning and tape speed compensation are discussed individually in the following paragraphs.

4.3.3.4.1 Tape Speed Compensation - The Model 4145 must be able to compensate for selected center frequency errors as great as 3-percent resulting from a 3-percent error in tape speed. A proportional reference discriminator, such as an EMR 210A/210T, detects the tape speed change and produces a voltage proportional to the percent of change. This voltage is applied to rear panel connector A3J2 and routed to pin 24 of card A2A7. However, the Model 4145 is a constant bandwidth system where center frequencies are deviated an "X" number of hertz and not a "Y" percent as in a proportional bandwidth system. Thus, for example, in band E operation a 3-percent error at the high end of the band (1600 KHz) is more hertz than a 3-percent error at the low end of the band (80 KHz). The function of the tape speed compensation circuitry is to make a fixed voltage, representing a percent of tape speed error, compensate proportionally more hertz across the band of frequencies.

This is accomplished by applying the TSC input voltage to a variable gain amplifier, Z1. The gain of amplifier Z1 is tunable, by means of a resistance ladder network, as a function of the selected center frequency. As described in paragraph 4.3.3.3, a discrete 12-bit binary value, representative of the selected subcarrier center frequency, is loaded into the digital control circuit group storage register. The eight most-significant bits of the stored value are applied to card A2A7 as binary weighted TSC command lines TS1 through TS128. Each active command line (0 volt level) causes an associated relay to energize. Table 4-3 shows typical command line/center frequency relationships for each of the five frequency bands. As shown in Table 4-3, no command lines are active for the lowest frequency in any of the five bands, thus no relays are energized. However, in order to compensate for tape speed errors at the low end of a frequency band, a fixed resistance (R80) is provided in the ladder network for establishing the gain of amplifier Z1. As the center frequency is tuned up on the front panel, appropriate command lines are activated causing associated relays to energize. Each relay energized inserts a precise resistance in parallel with R80 resulting in a decrease in resistance of the TSC ladder network, thereby increasing the gain to the tape speed compensation signal. The gain of the TSC ladder network is set for maximum deviation (±48 KHz) of the 450 KHz VCO at the highest center frequency in band E (1600 KHz) when the TSC error input is maximum (±4 volts).

4.3.3.4.2 Fine Tuning - The fine tuning portion of the VCO modulator circuit operates on a pure digital-to-analog conversion principal. The eight least-significant bits contained in the binary storage register of the digital control circuit group (refer to paragraph 4.3.3.3) are routed to card A2A7 as fine tuning command inputs (F1 through F128). Although the four most-significant fine tuning commands and the four least-significant tape speed compensation commands are received from the same bit locations in the binary storage register, these bits are applied to independent ladder networks. Each F number

Table 4-3. Typical Center Frequency/TSC Command Input Relationships

CENTER FREQUENCY					TSC COMMAND INPUT							
BAND A	BAND B	BAND C	BAND D	BAND E	128 (MSB)	64	32	16	8	4	2	1 (LSB)
5.0	10.0	20.0	40.0	80.0	1	1	1	1	1	1	1	1
5.4	10.8	21.6	43.2	86.4	1	1	1	1	1	1	1	0
5.8	11.6	23.2	46.4	92.8	1	1	1	1	1	1	0	1
6.6	13.2	26.4	52.8	105.6	1	1	1	1	1	0	1	1
8.2	16.4	32.8	65.6	131.2	1	1	1	1	0	1	1	1
11.4	22.8	45.6	91.2	182.4	1	1	1	0	1	1	1	1
17.8	35.6	71.2	142.4	284.8	1	1	0	1	1	1	1	1
30.6	61.2	122.4	244.8	489.6	1	0	1	1	1	1	1	1
56.2	112.4	224.8	449.6	899.2	0	1	1	1	1	1	1	1

1 = +5 Volts (Nonactive)

0 = 0 Volts (Active)

command line at a 0-volt level activates a binarily weighted segment of the fine tuning ladder network, either directly (F1, F2, F4, and F8) or through associated relay circuits (F16, F32, F64, and F128). Each activated segment of the ladder network provides an output proportional to the binary value of the command. Tuning up in front panel center frequency decreases the ladder resistance value. Thus, the output of the fine tuning ladder network is tunable over the range of approximately -3.6 volts to +4.6 volts which tunes the VCO down in frequency. Table 4-4 identifies typical center frequency/fine tuning commands relationships for each frequency band.

As shown in Table 4-4, in band E operation the fine tuning commands increment every 0.4 KHz and recycle every 182.4 KHz. (Divide by two for each successively lower frequency band.) The specific output level of the fine tuning ladder network derived from the fine tuning commands deviates the 450 KHz VCO within the frequency extremes identified as follows for each frequency band.

Band	VCO Deviation Range (KHz)
A	505.6 to 404.8
B	505.6 to 404.0
C	505.6 to 403.6
D	505.5 to 403.5
E	505.45 to 403.45

As shown above, band D is offset from the normal low end deviation by 100 Hz and band E is offset by 150 Hz. Since the front panel center frequency is incremented in 100 Hz steps, the offset in bands D and E help distribute, and thereby minimize, the tuning error (refer to Figure 4-6). The offset, which is inserted at summing amplifier Z2, is derived from -18 volt $\overline{D}$ or $\overline{E}$ band switching commands applied to pins 16 and 23, respectively, of card A2A7.

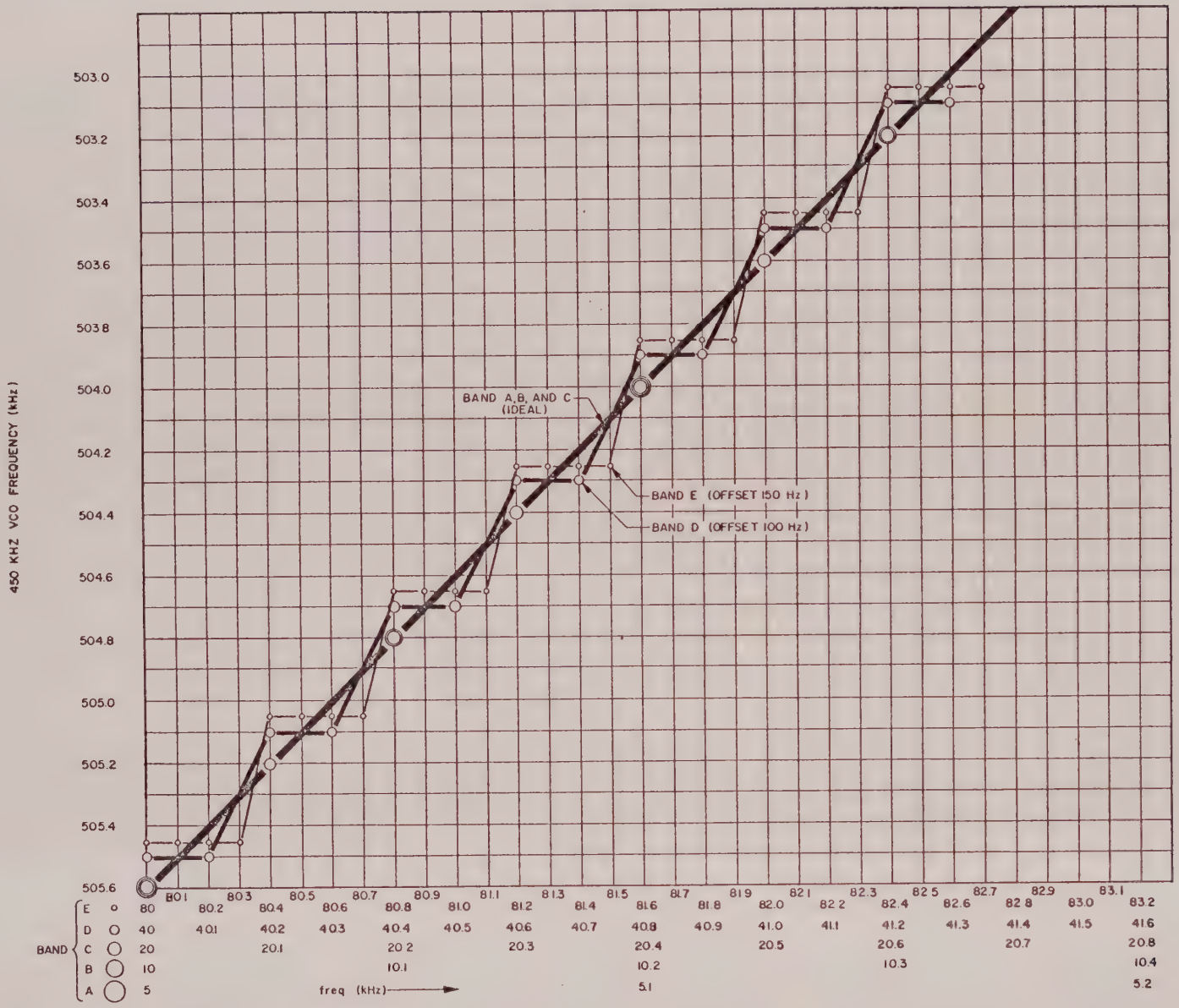
4.3.3.5 VCO and Temperature Regulator Card A4A1A1

The VCO is an astable circuit consisting of transistors Q1, Q4, Q11, Q12, and Q13. The nominal frequency of the VCO is established by discrete components which are selected to provide a center frequency of 450 KHz which may be deviated ±99 KHz. The input voltage level received from the VCO modulator circuit on card A2A7 controls the operating frequency of the VCO within the deviation parameters. The complementary frequency outputs of the VCO routed through a transformer driver (stages Q2 and Q3) and transformer coupled (T1) to the VCO/harmonic mixer card A2A6.

The 450 KHz VCO, and the 12.8 MHz crystal oscillator, and the +12 volt and -12 volt reference regulator circuits on card A4A1A2, are mounted in a temperature controlled environment, oven assembly A4A1, to increase stability of the frequency and voltage outputs. Temperature regulation of the oven assembly is accomplished by the circuitry consisting of transistors Q5 through Q9 on card A4A1A1, and thermistor RT1 and a heater element on the oven

Table 4-4. Typical Center Frequency/Fine Tuning Command Relationships

CENTER FREQUENCY (KHz)					FINE TUNING COMMANDS (F NO.)							
BAND A	BAND B	BAND C	BAND E	BAND F	128 (MSB)	64	32	16	8	4	2	1 (LSB)
5.0	10.0	20.0	40.0	80.0	1	1	1	1	1	1	1	1
-	-	20.1	40.2	80.4	1	1	1	1	1	1	1	0
-	10.1	20.2	40.4	80.8	1	1	1	1	1	1	0	1
5.1	10.2	20.4	40.8	81.6	1	1	1	1	1	0	1	1
5.2	10.4	20.8	41.6	83.2	1	1	1	1	0	1	1	1
5.4	10.8	21.6	43.2	86.4	1	1	1	0	1	1	1	1
5.8	11.6	23.2	46.4	92.8	1	1	0	1	1	1	1	1
6.6	13.2	26.4	52.8	105.6	1	0	1	1	1	1	1	1
8.2	16.4	32.8	65.6	131.2	0	1	1	1	1	1	1	1
11.4	22.8	45.6	91.2	182.4	1	1	1	1	1	1	1	1
					0 = 0 Volts (Active) 1 = +5 Volts (Nonactive)							



EMR Dwg. Control No. 4145-011

Figure 4-6. Center Freq. vs 450 KHz VCO Relationships

assembly container. Any change in ambient temperature within the oven assembly is detected by RT1 changing its resistive characteristic, thus changing the sensing input to differential amplifier Q8/Q9. The amplified error signal is applied to regulator driver stage Q8 which controls the conduction of series regulators Q5 through Q7. The series regulators in turn control the oven assembly heater element. Therefore, any temperature change of internal oven temperature is compensated for by an inversely proportional change in the output of the heater element.

4.3.3.6 VCO and Harmonic Mixer Card A2A6

The VCO and harmonic mixer card is composed of four bandpass filters, two balanced modulators, and a times-five multiplier. These circuits mix the output of the 450 KHz VCO (card A4A1A1) with the selected harmonic received from card A2A5 to produce complementary local oscillator signals. The local oscillator signals (L.O. and $\overline{\text{L.O.}}$) reflect the coarse tuning, fine tuning, and tape speed compensation requirements for tuning the Model 4145 to a specific subcarrier center frequency.

A semisquare-wave signal, at a fixed frequency within range of 450 ±99 KHz, is applied to pin 1 of card A2A6 from the 450 KHz VCO on card A4A1A1. This signal, representing the fine tuning and tape speed compensation requirements for the selected subcarrier channel, is coupled through a 450 KHz ±25% bandpass filter circuit to summing mixer M1. The filter, which is composed of inductor assemblies L4 through L7 and integrated circuit modules Z1 through Z4, reduces all harmonics of the input signal so that the filter output applied to mixer 1 is essentially a pure sine wave. The second input to mixer 1 is a precision 2 MHz frequency derived from the 400 KHz square wave received at pin 26 and coupled through a times-five multiplier circuit. The multiplier, composed of transistor Q1 and integrated circuit module Z9, is a double-tuned input, double-tuned output differential type amplifier. Each double-tuned section of the multiplier is tuned for 2.0 MHz or the fifth harmonic of the input square wave and is broadband enough that component tolerances do not affect performance.

Mixer 1 is of a balanced modulator configuration whereby both inputs are reduced by at least 30 Db. One input to the mixer is considered the carrier signal and is used to drive internal diode quads in and out of conduction. The second input signal is maintained at a lower level and is essentially chopped by the carrier signal. In the case of mixer 1, the 2.0 MHz signal is the carrier which chops the 450 ±99 KHz input signal.

The output of mixer 1 is primarily the sum and difference of the two input signals. The output also contains odd harmonics of the carrier signal and their associated sidebands. The desired output of mixer 1, the sum of the two input signals, is passed by a 2.45 MHz ±5% bandpass filter composed of inductor assemblies L8 through L11 and integrated circuit modules Z5 through Z8. The filter output, which is a sine wave, is applied to a second balanced mixer assembly where it is chopped by the specific harmonic of 102.4 KHz

selected on card A2A5. This harmonic, which is one of 15 incremental steps ranging from 6.0416 MHz to 7.4752 MHz, represents the coarse tuning requirement for tuning the Model 4145 to a selected subcarrier channel. The selected harmonic is received at pin 36 of card A2A6 and coupled through a 6.8 MHz ±12% filter composed of two fixed, double-tuned, cascaded filter stages (Q2 and Q3) and applied to mixer 2 as a sine wave.

The output of the second mixer assembly, which is also composed of the sum and difference of the input signals, is amplified by transistor stages Q4 and Q5 and applied to a 4.3 MHz ±20% bandpass filter consisting of inductor assemblies L22 through L25 and integrated circuit modules Z10 through Z14. This filter, which is tuned for the difference frequency provided by mixer 2, has complementary outputs. These outputs are used to drive a differential squaring circuit on card A2A9 in the channel selector circuit group and are complementary to offer greater symmetry. The output signals thus generated may range in frequency from 3.536 MHz to 5.0716 MHz and serve as the local oscillator signals for heterodyning with the FM multiplex input of the channel selector circuit group.

4.3.4 Channel Selector Circuit Group (Ref. Figure 4-7)

4.3.4.1 General

The circuits of the channel selector circuit group are located on delay line and low-pass card A2A8, first IF card A2A9, second IF card A2A10, and detector card A2A11. The functions of the channel selector circuit group are to separate a selected subcarrier channel from an FM multiplex input by means of a double heterodyning process, and to demodulate the intelligence data on the selected channel by means of pulse averaging detection.

4.3.4.2 Delay Line and Low-Pass Card A2A8

The FM multiplex output from card A2A7 of the input control and metering circuit group is applied to pin 5 of card A2A8, coupled through buffer amplifier Q3, and applied to a tapped delay line consisting of inductors L1 through L37. The delay line provides five delayed FM multiplex outputs, one associated with each of the bands of frequencies selectable on front panel DEVIATION (±kHz) switch A1S2. Each of the delayed FM multiplex signals is coupled through an associated buffer amplifier (Q1, Q4, Q6, Q9, and Q11), and a low-pass filter to a diode switch. One of the five switches is enabled by +18 volt and −18 volt switching command inputs received from the band switching control circuits. The command inputs to the other diode switches are in complementary form (−18 volt and +18 volt) which reverse biases the associated switches. The delayed FM multiplex band of frequencies associated with the enabled diode gate is coupled through buffer amplifier Q8 to output pin 36 on card A2A8. The overall delay, provided by the delay line and low-pass filter for the selected band of frequencies, is equivalent to the delay encountered by the tape speed compensation signal as it is processed by the frequency synthesizer circuit group.

BAND SWITCHING INPUT FROM A2A6 (REF. FIGURE 4-3)

$\overline{E}$ E $\overline{D}$ D $\overline{C}$ C $\overline{B}$ B $\overline{A}$ A

8 9 10 11 26 27 28 29 33 34

DELAY LINE AND LOW-PASS CARD A2A8 (REF. FIGURE 5-16)

MULTIPLEX IN FROM A2A7 (FIGURE 4-2) → 5

Q3

DELAY LINE

L1 THRU L9

Q1

L10 THRU L24

Q4

L25 THRU L31

Q6

L32 THRU L34

Q9

L35 THRU L37

Q11

100 KHz LOW-PASS FILTER

L38, L39, & C4 THRU C6

Q2

L40 & C7

CR1 THRU CR4

200 KHz LOW-PASS FILTER

L41, L42, & C20 THRU C22

Q5

L43 & C23

CR5 THRU CR8

400 KHz LOW-PASS FILTER

L44, L45, & C32 THRU C34

Q7

L46 & C35

CR9 THRU CR12

800 KHz LOW-PASS FILTER

L47, L48, & C47 THRU C49

Q10

L49 & C50

CR13 THRU CR16

1600 KHz LOW-PASS FILTER

L50, L51, & C57 THRU C59

Q12

L52 & C60

CR17 THRU CR20

Q8

36

11

FIRST IF CARD A2A9 (REF. FIGURE 5-18)

+18V

R2

MIXER 1

Q4, Q5

Q1

Q2, Q3

PHASE SPLITTER

SQUARING CIRCUIT

L.O. INPUT

1

Q17

FROM VCO AND HARMONIC MIXER A2A6 (FIGURE 4-5)

-5.2V

Q18

R139

L.O. INPUT

5

Q19

DWG. CONTROL NO. 4145-012

9 8 18 16 22 21 20 27 30 29

216 KHz ±4.5%
B.P. FILTER
L3 THRU L6 & Z1 THRU Z4

CR10-
CR13

TP2

432 KHz ±4.5%
B.P. FILTER
L7 THRU L10 & Z5 THRU Z8

CR24-
CR27

864 KHz ±4.5%
B.P. FILTER
L11 THRU L14 & Z9 THRU Z12

CR34-
CR37

1728 KHz ±4.5%
B.P. FILTER
L15 THRU L18 & Z13 THRU Z16

CR44-
CR47

3456 KHz ±4.5%
B.P. FILTER
L19 THRU L22 & Z17 THRU Z20

CR54-
CR57

+18V

R24

MIXER 2

MIXER QUADS

TP3

Q11
Q12

Q8

Q9
Q10

PHASE SPLITTER

CR15-CR18

CR19-CR22

-5.2V

Q13

Q14

DIFF. AMP.

AMP.
Q15
Q16

36 36

BINARY DIVIDER
(÷ 2, 4, 8, 16, OR 32)
Z28 THRU Z32

COUNTER CONTROL
Z33 & Z34

B,C,D,E

34

6.4 MHz
(FIG. 4-5)

SECOND IF CARD A2A10
(REF. FIGURE 5-20)

18 16 4 8 23 19 32 24 25 30

16 KHz ±6.25%
B.P. FILTER
FL1

CR25

CR26-CR29

CR30

32 KHz ±6.25%
FL2

CR19

CR20-CR23

CR24

64 KHz ±6.25%
FL3

CR13

CR14-CR17

CR18

128 KHz ±6.25%
FL4

CR7

CR8-CR11

CR12

256 KHz ±6.25%
FL5

CR1

CR2-CR5

CR6

Q1

R32

-18V

R36

Q2

TP1

11

9

TO INPUT
LEVEL ADJUST
A2A7 (REF.
FIGURE 4-2)

BAND SWITCHING COMMANDS

CARD	PIN NO'S.									
A2A8	9	18	22	28	30	8	16	21	27	29
A2A9	9	18	22	28	30	8	16	21	27	29
A2A10	18	4	23	32	25	16	8	19	24	30
A2A11	32	30	29	28	27	--	--	--	--	--

BAND	A	B	C	D	E	$\bar{A}$	$\bar{B}$	$\bar{C}$	$\bar{D}$	$\bar{E}$
A	+	-	-	-	-	-	+	+	+	+
B	-	+	-	-	-	+	-	+	+	+
C	-	-	+	-	-	+	+	-	+	+
D	-	-	-	+	-	+	+	+	-	+
E	-	-	-	-	+	+	+	+	+	-

+ = +18V
- = -18V

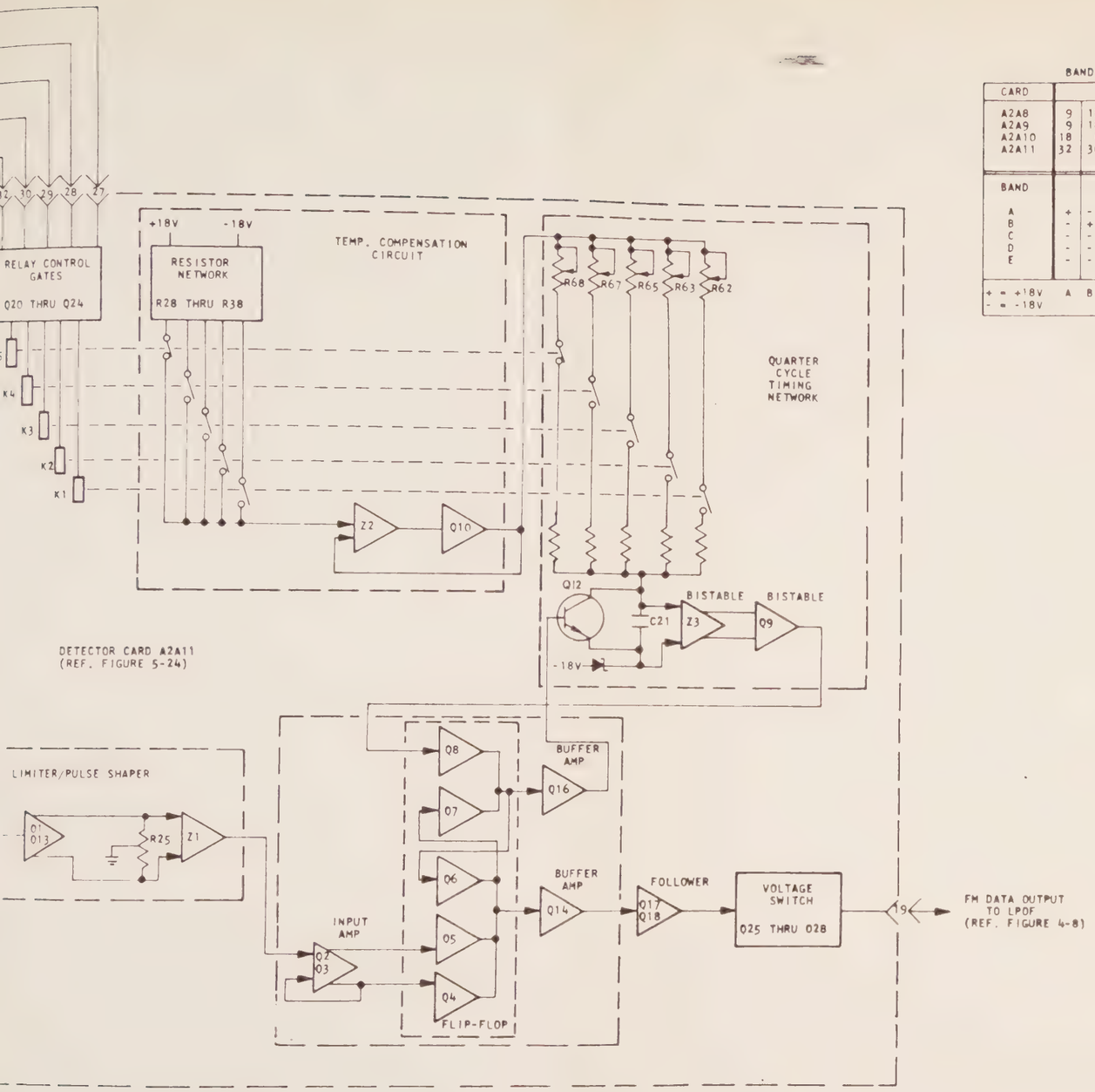


Figure 4-7. Channel Selector Circuit Group Functional Block Diagram

4.3.4.3 First IF Mixer Card A2A9

The first IF card A2A9 is composed of two identical mixer circuits separated by selectable intermediate frequency filters and two binary divider chains, one associated with each mixer. Each mixer is of a balanced modulator configuration consisting of an active phase splitter, two diode series mixing quads, and a differential amplifier. The FM multiplex band selected on delay line and low-pass card A2A8 is applied to card A2A9 at pin 11; coupled through mixer 1 phase splitter, Q1 through Q5; and applied to mixer 1 quads, CR1 through CR4 and CR5 through CR8 in complementary form. The second inputs to mixer 1 are the appropriate binary submultiples of the 4.3 MHz ±20% local oscillator (L.O. and $\overline{\text{L.O.}}$) inputs received from the tuning control functional circuit group. The sine wave L.O. and $\overline{\text{L.O.}}$ signals, containing the channel selection tuning control and tape speed compensation for the overall system, are applied to pins 1 and 5, respectively, of card A2A9 and routed through a differential squaring circuit, Q17 through Q19. The squaring circuits provide levels which are compatable with the binary divider circuit associated with the first mixer. When operating on the ±16 KHz deviation band (band E), the local oscillator signals are coupled directly through the divider and mixer 1 differential amplifier, Q6 and Q7, to the mixer 1 quads. As lower deviation bands are selected, the binary divider provides a proportionally lower submultiple of the 4.3 MHz ±20% signals to the first mixer.

The FM multiplex is chopped in the mixer quads at the rate of the binary divider chain output. The resultant output of the mixer 1 consists of the sum and difference of the two input signals and the odd order harmonics of the chopping frequency and their respective sidebands. The output of mixer 1 is applied to the five bandpass filter circuits on card A2A9. These filters are tuned to center frequencies of 216 KHz, 432 KHz, 864 KHz, 1728 KHz, and 3456 KHz corresponding to ±1, ±2, ±4, ±8, and ±16 KHz deviation selections, respectively. Each filter has a bandwidth of ±4.5%. The ±18 volt band switching inputs are applied to the five filters such that only the filter and diode switching gate associated with the deviation band selected is activated. All other diode gates are reverse biased and the other filters receive no DC power.

The output of the selected filter is coupled to mixer 2 where it is chopped by a precise frequency provided by a second binary divider chain. The operation of mixer 2, composed of phase splitter Q8 through Q12, diode mixer quads CR15 through CR18 and CR19 through CR22, and differential amplifier Q13/Q14, is identical to that of mixer 1. The drive signal for the second binary divider chain is the 6.4 MHz input applied to card A2A9 at pin 34. This signal is derived on harmonic selector card A2A5 from the 12.8 MHz crystal oscillator signal. The 6.4 MHz is divided by 32, 16, 8, 4, or 2 for deviation band selections of ±1, ±2, ±4, ±8, and ±16, respectively. The resultant output of mixer 2 is coupled through amplifier Q15/Q16 to pin A2A9-36 from where it is routed to second IF card A2A10. Amplifier Q15/Q16 has a gain of 12 Db which compensates for the 6 Db losses incurred in each of the two mixers.

4.3.4.4 Second IF Card A2A10

The second IF card, A2A10 is composed of five selectable intermediate frequency filters (FL1 through FL5), each with an associated diode switching gate, and two output buffer amplifiers Q1 and Q2. The center frequencies of the filters are 16 KHz, 32 KHz, 64 KHz, 128 KHz, and 256 KHz which are associated with the ±1, ±2, ±4, ±8, and ±16 deviation band selections respectively. The bandwidth of each filter is ±6.25% of center frequency.

The output of mixer 2 on card A2A9 is received at pin 36 of the second IF card and coupled to each of the five filters. Band switching commands initiated by DEVIATION (±kHz) switch A1S2 enable the diode switching gate and filter associated with the deviation band selected. The other diode switching gates are reverse biased and no DC power (±18 volts) is applied to the associated filters.

The output of the selected filter and diode switching gate is coupled through buffer amplifier Q1 to pin A2A10-11 for distribution to detector card A2A11. The selected intermediate frequency output is also coupled through buffer amplifier Q2 to pins A2A10-5 and A2A10-9.

4.3.4.5 Detector Card A2A11

The intelligence data associated with the selected subcarrier channel is coupled from second IF card A2A10 to pin 1 of detector card A2A11. The sine wave data input to card A2A11 is applied to a limiter/pulse shaper circuit composed of transistors Q1 and Q13 and integrated circuit Z1. This circuit amplifies and converts the sine wave input to a relatively constant-amplitude square wave signal, representative of the selected subcarrier data. Zero signal crossings of the input sine wave are maintained, thus maintaining the modulation component of the subcarrier signal. The resultant square wave signal is applied to a bistable circuit composed of input amplifier Q2 and Q3, flip-flop Q4 through Q8, and output buffer amplifiers Q14 and Q16. Each transition of the square wave input triggers the input amplifier which provides complementary input triggers to transistor stages Q4 and Q5 of the flip-flop. A negative going trigger to either Q4 or Q5 causes the common output of Q4, Q5, and Q6 to go "high". The "high" condition is coupled to transistor Q7 causing the common output of Q7 and Q8 to assume the "low" state. The "low" condition is applied through buffer amplifier Q16 to the base of transistor Q12 in the timing network causing Q12 to turn off. When Q12 is in the off state capacitor C21 charges through one of five timing potentiometers (R62, R63, R65, R67 or R68) as selected by the band switching command inputs. The timing potentiometers are adjusted such that with a center frequency input capacitor C21 is charged to the triggering point of bistable Z3 precisely at the quarter-cycle point of the input square wave. Triggering Z3 causes bistable Q9 to be triggered with the resultant negative going output applied to stage Q8 of the flip-flop. The negative trigger applied to Q8 drives the common output of Q7/Q8 to the "high" state and the common output of Q4, Q5, and Q6 to the low state. The "high" output is also coupled through Q16 to turn on timing transistor Q12. This operation is repeated for each half-cycle of the input square wave. Since the duration of the positive quarter-cycle

output of flip-flop stages Q4, Q5, and Q6 is fixed by the charge time of capacitor C21 for the specific deviation band selected, it can be seen that as the frequency of the data input square wave increases the negative quarter-cycle is of shorter duration. Conversely as the frequency of the data signal decreases the negative quarter-cycle becomes greater than the positive.

The output of stages Q4, Q5, and Q6 of the flip-flop is coupled through buffer amplifier stage Q14 and emitter-follower stages to a voltage switch circuit composed of transistor Q25 through Q28. The voltage switch operates from the FM detector output to establish precise amplitude levels for the detected subcarrier signal. This is a cross-coupled network which is triggered on every edge of the FM detector output. Zener diodes, connected to the ±18 volts regulated DC supplies, establish reference voltages of +15 volts and −15 volts. The square-wave input to the voltage switch is then converted to an output signal with a ±15 volts magnitude. This signal is applied to pin 19 of card A2A11 for distribution to the low-pass output filter and output amplifier circuit group.

4.3.5 Low-Pass Output Filter and Output Amplifier Circuit Group (Ref. Figure 4-8)

This circuit group consists of a tunable, five-pole low-pass filter circuit and an output amplifier circuit. Individual descriptions of these circuits are provided in the following paragraphs.

4.3.5.1 Low-Pass Output Filter Circuit

The low-pass output filter is composed of five relay-tunable, RC filter networks, each of which is followed by an isolation amplifier. One RC network and associated isolation amplifier are contained on single pole card A2A12 and pole pair cards A2A13 and A2A14 each contain two RC networks and associated isolation amplifiers. The function of the low pass filter circuitry is to suppress undesired high frequency components in the signal received from the FM detector, card A2A11, thereby providing a noise-free output signal representative of the data contained in the selected subcarrier channel. Filter cutoff frequencies between 10 Hz and 99.9 KHz are selectable to three significant digits. Also, either constant amplitude (CA) or constant delay (CD) filter response characteristics may be selected. Selection of the operating parameters for the low pass filter may be controlled from either the front panel of the Model 4145 or from an external source. The front panel LOCAL/REMOTE switch selects the desired mode of operation. Since the operation of each RC network and its associated isolation amplifier is similar, the operation of the filter pole located on single pole card A2A12 is discussed.

Control relays K1 through K18 are energized by completing the DC return path for the relay coils through LPOF switch A1S8 and DATA CUTOFF switches A1S9 through A1S12. Switch A1S8 provides a return for relay K17 when a constant amplitude response is selected and for relay K18 when a constant delay response is selected. Front panel DATA CUTOFF switches S10 through S12 provide binary-coded-decimal command inputs (ground levels) to relays K1 through K12. Each combination of three digits programmed on DATA CUTOFF

switches A1S10 through A1S12 cause an appropriate combination of control relays K1 through K12 to be energized. DATA CUTOFF switch A1S9 provides a ground return to appropriate combinations of relays K13 through K16 for selecting the desired data cutoff frequency range (10 to 99.9 Hz, 100 to 999 Hz, 1 to 9.99 KHz, or 10 to 99.9 KHz). Switch A1S9 also controls lighting of the appropriate decimal point indicator between switches S9 through S12.

Contacts of control relays K1 through K12 provide for selection of resistive components R1 through R12 and contacts of relays K13 through K18 provide for selection of capacitive components C1 through C10. Thus a discrete RC filter network is established for each set of data cutoff frequency/response characteristic parameters selected. The RC component values are selected to exhibit the proper frequency attenuation for the selected cutoff frequency.

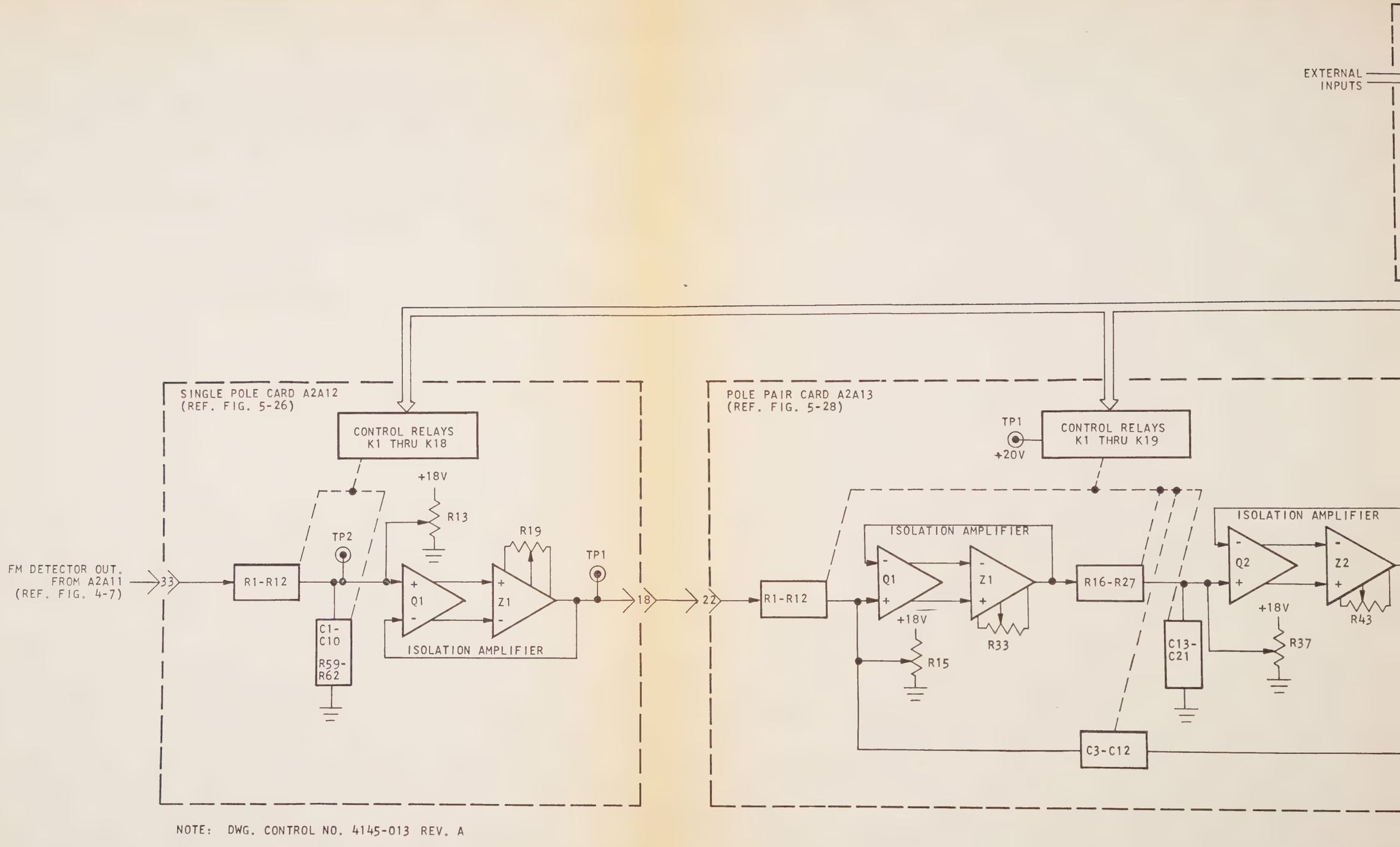
In order to prevent interaction between the filter poles in the low-pass output filter circuit, isolation amplifiers are used between each RC network. The isolation amplifier on single pole card A2A12 is composed of differential input stage Q1 and operational amplifier stage Z1, and has a DC gain of 2.5. Potentiometers R13 and R19 provide a means of adjusting the amplifier for zero offset. Each isolation amplifier on the pole pair cards has a $\sqrt{2}$ gain or, an overall gain of 2 for each card. Thus the total DC gain for the low pass output filter circuit is 10.

The primary difference in functional operation of the single pole filter and the operation of pole pair cards A2A13 and A2A14 is the in-phase feedback loop between the output of the second isolation amplifier and the input of first isolation amplifier on each pole pair card. The purpose of the active feedback loops is to shape the frequency response in a manner that is not possible with only passive components. Each feedback loop, in effect, varies capacity as a function of frequency in order to maintain the actual output response curve at an amplitude level as close as possible to the optimum curve shown in Figure 2-1.

4.3.5.2 Output Amplifier Circuit

The output amplifier circuit is composed of the front panel BANDEDGE VOLTS control A1R1, rear panel DEVIATION SENSE switch A3S1, and the zero signal relay K1, polarity sense relay K2, and transistor stages Q2 through Q8, Q10, and Q11 located on regulator/output amplifier card A2A15. The filtered data output from the low pass output filter is routed from pin 20 of pole pair card A2A14 to the BANDEDGE VOLTS potentiometer A1R1. Potentiometer A1R1 controls the amplitude of the data signal input applied to the output amplifier thus controlling the resultant output amplitude. The BANDEDGE VOLTS control is adjusted to provide specific output levels, within the range of +10 volts to −10 volts, for peak upper and lower bandedge deviation, respectively.

The adjusted data signal is applied to card A2A15 at pin 19 and routed through contacts of zero signal relay K1 and polarity sense relay K2 to the output amplifier. If the amplitude of the selected subcarrier input signal is below a preset level, a



NOTE: DWG. CONTROL NO. 4145-013 REV. A

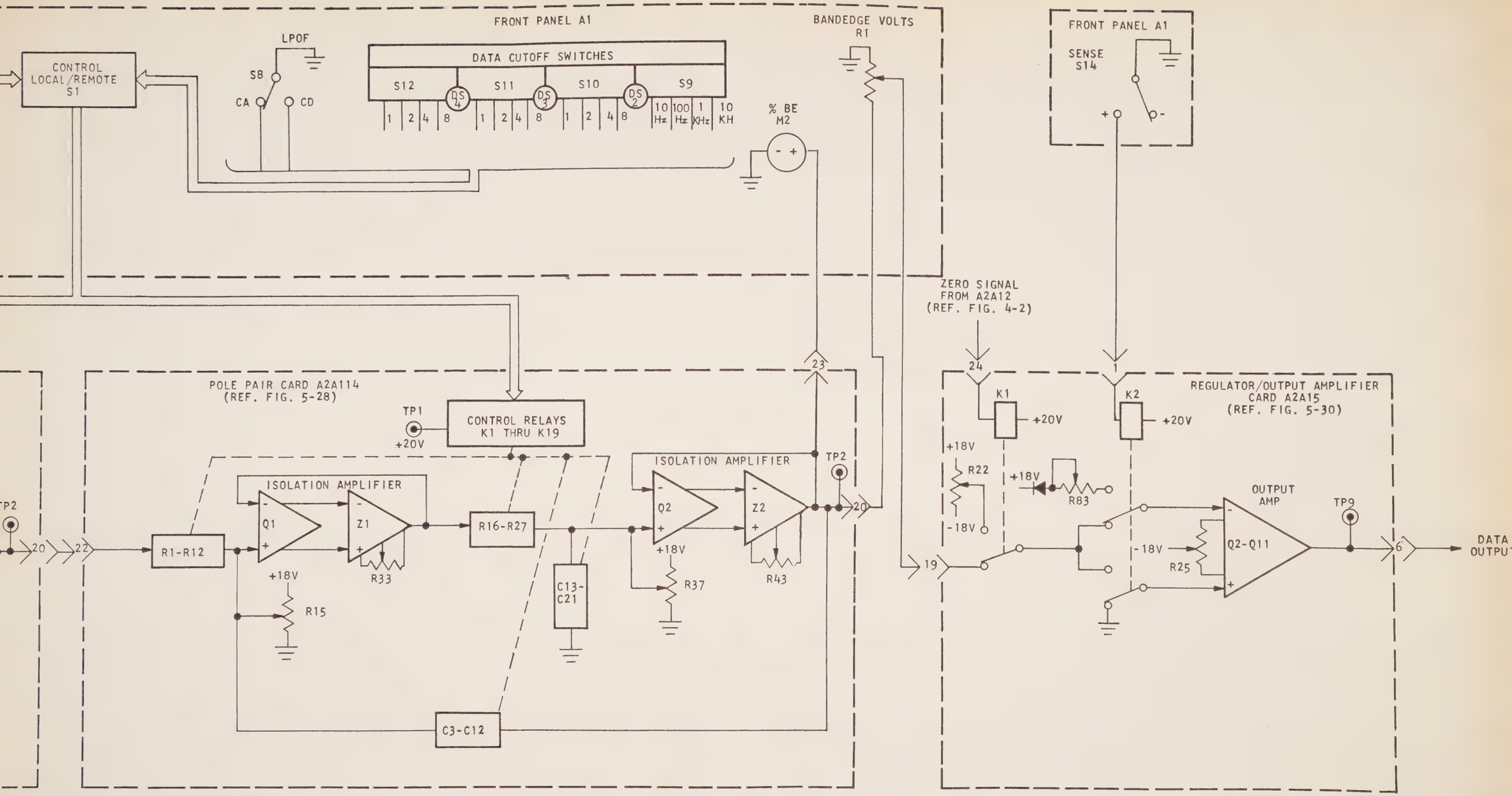


Figure 4-8. Low-Pass Output Filter and Output Amplifier Circuit Group Functional Block Diagram

zero signal (ground) is applied to relay K1 from the input control and metering circuit (refer to paragraph 4.3.2) causing K1 to energize. When relay K1 is energized, the input to the output amplifier is clamped to a value preset at potentiometer R22. Potentiometer R22 is normally adjusted to provide a data output level of +11 volts or −11 volts, depending on the deviation sense mode of operation, thus providing an off-scale indication to recording devices monitoring the discriminator output. This value may set at any value between +11 volts and −11 volts as required by the user. Polarity sense relay K2 is controlled by the front panel SENSE +/− Switch A1S14. With switch A1S14 in the (−) position relay K2 is de-energized and the output voltage becomes more negative as the frequency of the selected subcarrier channel increases. When the positive sense mode of operation is selected, relay K2 is energized shifting the reference input to the operational amplifier. As a result the output voltage becomes more positive as the input frequency increases.

The output amplifier is composed of a differential input amplification stage (Q2, Q3, Q4, and Q8), dual complementary emitter follower output stages (Q5/Q12 and Q6/Q10), and current limiter stages Q7 and Q11. (See Figure 5-30.) The gain of the amplification stage is approximately 1.5. The dual complementary emitter-follower stage provides for a low impedance, high-current output. The limiter stages limit the output current to 100 milliamperes minimum and 140 milliamperes maximum.

4.3.6 Power Supply and Voltage Regulators Circuit Group (Ref. Figures 5-30 and 5-33)

The power supply and voltage regulators circuit group is the primary source of all DC voltages required for operation of the Model 4145 CBW Tunable Discriminator. The power circuits are located on power supply assembly A4 and regulator/output amplifier card A2A15. As shown in Figure 5-33 the primary AC power is routed from rear-panel connector A3J6 through fuse A3F1 to the front panel POWER switch A1S13. Switch A1S13 controls application of the AC power input to rear panel blower B1 and to the primary winding of power transformer A4T1. Three secondary windings of transformer A4T1 are connected to full-wave diode bridge rectifiers A4CR1, A4CR2, and A4CR3. These rectifiers provide the unregulated DC voltage inputs to five voltage regulator circuits on card A2A15 (see Figure 5-30). Since the operation of each regulator circuit on card A2A5 (+18V, −18V, +5.2V, −5.2V, and +20V) is similar, only the operation of the +18 volt regulator is discussed in detail.

The +18 volt regulator circuit is composed primarily of a series regulator, A4Q1, a regulator driver, A2A15Q1, and a differential comparison amplifier A2A15Q9. The unregulated +18 volt output of diode bridge rectifier A4CR1 is routed from pin A2A15-5 through fuse F1, pin A2A15-2, series regulator A4Q1, pin A2A15-16, and applied to pin A2A15-15 for distribution to the discriminator circuits. Regulator driver A2A15Q1 provides the base drive current for the series regulator. Regulation is accomplished by comparing a sample of the output voltage sensed by potentiometer R24 with a reference voltage established by zener diode

CR12. The differential comparison amplifier senses the magnitude and direction of any output voltage changes and produces an output that is proportionally equal and opposite to the error detected. The error signal output controls the biasing of regulator driver Q1 which in turn controls the conduction of series regulator A4Q1, thus compensating for the output voltage change. The functional operation of each regulator on card A2A15 is similar except that the +20 volt regulator is not adjustable.

MAINTENANCE

SECTION 5

MAINTENANCE

5.1 GENERAL

This section contains information to aid in troubleshooting and maintaining the Model 4145 CBW Tunable Discriminator. This information is intended to be used with the circuit descriptions contained in Section 4 to maintain the Model 4145 at the optimum operational status. Maintenance information included in this section includes a troubleshooting guide (paragraph 5.2); checkout and adjustment procedures (paragraph 5.3); lubricating instructions for the Rotron muffin fan (paragraph 5.4); and assembly, schematic, and wiring diagrams (Figures 5-1 through 5-39).

5.2 TROUBLESHOOTING GUIDE

In the event an abnormal condition is detected, or suspected, in the operation of the Model 4145, the following general method of isolating and repairing the trouble is recommended:

a. Perform a visual inspection (paragraph 5.2.1).

b. Perform the checkout and adjustment procedures (paragraph 5.3) to localize a malfunction to a functional circuit.

c. Use standard maintenance techniques, based on a knowledge of normal circuit operation (Section 4), and the assembly, schematic, and wiring diagrams (Figures 5-1 through 5-39), isolate the failure to a replaceable part.

d. When the defective component is located, refer to Section 6, Parts Lists, for description and part number of replacement component.

e. After replacing components, repeat applicable checkout and adjustment procedures to ascertain that the original failure has been removed and that a new failure has not been introduced.

5.2.1 Visual Inspection

The Model 4145 should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. The following visual inspection should be performed periodically as a means of preventive maintenance, or, if a malfunction occurs, to aid in isolating the trouble.

a. Inspect wiring for loose or broken connections.

b. Inspect front and rear-panel connectors, switches, and controls for signs of damage.

c. Inspect printed-wiring cards for mechanical damage or component discoloration.

d. Inspect card tray, card guides, and card mating connectors for signs of damage.

5.3 CHECKOUT AND ADJUSTMENT

The procedures contained in this paragraph are designed to provide a means for evaluating the operational status of the various functional circuits contained in the Model 4145 CBW Tunable Discriminator. Where applicable, instructions are provided in the checkout procedures for restoring a malfunctioning circuit to within acceptable operational limits by adjustment. References are provided in the procedural instructions to applicable circuit descriptions contained in Section 4, in the event troubleshooting a malfunctioning functional circuit is required.

Several circuits contain components which are aged at the factory to provide optimum performance. These components are identified either by an asterisk and note on the schematic diagram or in a NOTE on the page preceding the schematic. When replacing any of these components, order the component from EMR. Specify "aged" component and the assembly number of the card for which it is required. See Section 6 for the correct parts list for each assembly.

The appropriate checkout and adjustment procedures should also be performed following replacement of components to verify that the failure has been corrected.

5.3.1 Test Equipment Required

The following test equipment or equivalent is recommended for the checkout and adjustment procedures outlined in this section.

a. DC Voltmeter: John Fluke 825A or equivalent.

b. Signal Generator: Waveforms 401 or equivalent.

c. RMS Meter: Hewlett-Packard 400L or equivalent.

d. Frequency Counter: Hewlett-Packard 5245L or equivalent.

e. Oscilloscope: Tektronix 545A or equivalent.

5.3.2 Voltage Regulators

To check the operation of the power supply assembly, A4, and the voltage regulator circuits on cards A2A15 and A4A1A2, proceed as follows:

NOTE

If one or more of the following voltage levels are excessively out of tolerance, troubleshoot the power supply circuits (ref. paragraph 4.3.6) before attempting adjustment.

a. Connect a Fluke 825A DC voltmeter between TP1 (+) and TP4 (ground) on card A2A15. The voltmeter should indicate +18 volts ±50 millivolts. Adjust potentiometer A2A15R24, if necessary, to obtain proper indication.

b. Connect the DC voltmeter between TP2 (−) and TP4 (ground) on card A2A15. The voltmeter should indicate −18 volts ±50 millivolts. Adjust potentiometer A2A15R53, if necessary, to obtain proper indication.

c. Connect the DC voltmeter between TP5 (−) and TP4 (ground) on card A2A15. The voltmeter should indicate −5.2 volts ±50 millivolts. Adjust potentiometer A2A15R73, if necessary, to obtain proper indication.

d. Connect the DC voltmeter between TP3 (+) and TP4 (ground) on card A2A15. The voltmeter should indicate +5.2 volts ±50 millivolts. Adjust potentiometer A2A15R58, if necessary, to obtain proper indication.

e. Connect the DC voltmeter between TP6 (+) and TP4 (ground) on card A2A15. The voltmeter should indicate +20 ±0.5 volts. This level is not adjustable.

f. Connect the DC voltmeter between pin 34 of connector A2J7 and ground. The voltmeter should indicate −12V ±1 Mv. Adjust potentiometer A4A1A2R22 (access to potentiometer provided through cover on oven assembly), if necessary, to obtain proper indication.

g. Connect the DC voltmeter between terminal 3 of BALANCE potentiometer A1R2 and ground. The potentiometer should indicate approximately +12 volts (+11 volts to +13 volts satisfactory). If necessary, adjust potentiometer A4A1A2R18 (access to potentiometer available through cover of oven assembly) to obtain proper indication.

NOTE

If potentiometer A4A1A2R18 is adjusted, the VCO modulator circuit must be readjusted. (Reference paragraph 5.3.6.)

5.3.3 Input Control and Metering Circuit Group Checkout

The following procedure is designed for checkout and adjustment of the input metering and zero signal detection functions of the input control and metering circuit group. If proper output indication cannot be obtained by adjustment, refer to paragraph 4.3.1 for circuit descriptions.

a. Connect the Waveforms 401 signal generator and the Hewlett-Packard 400L RMS voltmeter to rear panel INPUT connector A3J3.

b. Adjust the signal generator for a frequency of 100 KHz and an amplitude of 1.0 volts as indicated on the H-P 400L voltmeter.

c. Set the Model 4145 front panel controls as follows:

Control	Position
CENTER FREQUENCY (kHz) Switches A1S3 thru A1S7	0100.0
DEVIATION (±kHz) Switch A1S2	4
CONTROL LOCAL/REMOTE Switch A1S1	LOCAL

d. On card A2A7 adjust potentiometer R64 to the point at which front panel FULL SCALE 10 indicator A1DS7 just comes on.

e. Adjust the output amplitude of the signal generator for 0.1 volts as indicated on the H-P 400L voltmeter.

f. On card A2A7 adjust potentiometer R135 to the point at which FULL SCALE 0.1 indicator A1DS7 just comes on.

g. Adjust the output amplitude of the signal generator for 0.5 volts. Observe that FULL SCALE 1.0 indicator A1DS6 is on.

h. Adjust the output amplitude of the Waveforms 401 oscillator for 20 millivolts as indicated on the H-P 400L voltmeter.

i. On card A2A2 adjust potentiometer R45 to the point at which SIGNAL LOSS indicator A1DS8 just comes on.

5.3.4 Tuning Accuracy Checkout and Adjustment Procedure

The following procedure is designed to check the accuracy of the Model 4145 in tuning to a selected subcarrier center frequency. The procedure is intended to check the input metering and control circuit group, channel selector circuit group, tuning control circuit group, and digital control circuit group. Where applicable, instructions are provided for adjusting discriminator signals to within acceptable tolerances. References are provided in the procedural instructions to applicable circuit descriptions in Section 4, if troubleshooting is deemed necessary.

Perform the tuning accuracy checkout procedure as follows:

a. On the rear panel of the Model 4145, connect the 100 KHz test signal (connector A3J4) to INPUT connector A3J3 and connect grounding cap to TSC connector A3J2.

b. Set the Model 4145 front panel controls as follows:

Control	Position
CENTER FREQUENCY (kHz) Switches A1S3 thru A1S7	0100.0
DEVIATION (±kHz) Switch A1S2	16
DATA CUTOFF Switches A1S9 thru A1S12	200 Hz
LPOF Switch A1S8	CD

c. Connect the frequency counter between test jacks A1TP4 (MX IN) and A1TP1 (GRD) on the front panel. The counter should indicate 100 KHz ±1.0 Hz. If indication is abnormal, recheck output frequency at A1TP4 using an oscilloscope. If indication is still abnormal, proceed to step q. Also, observe that FULL SCALE indicator A1DS6 is on. If this indication is abnormal, refer to paragraph 5.3.3.

d. Connect the frequency counter between pin 5 of card A2A8 and ground. The counter should indicate 100 KHz ±1.0 Hz. If the indication is abnormal, troubleshoot the input control and metering circuit group. (Refer to paragraph 4.3.1.)

e. Connect the frequency counter between pin 36 of card A2A8 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range (1, 2, 4, 8, and 16) and check the output frequency for each position. The counter should indicate 100 KHz ±1.0 Hz in each band. If indications are abnormal, troubleshoot delay line and low-pass card A2A8 (ref. paragraph 4.3.4.2) and the band switching circuit (ref. paragraph 4.3.2).

f. Connect the frequency counter between test jack A2A9TP1 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and check the output frequency as indicated below:

Switch A1S2 Position	Counter Indication
1	316 KHz
2	532 KHz
4	964 KHz
8	1828.05 KHz
16	3556.15 KHz

If the indications are abnormal, proceed to step j.

g. Connect the frequency counter between test jack TP2 on card A2A9 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and check the frequency indication on the counter for each position. Normal indications are as follows:

Switch A1S1 Position	Counter Indication
1	216 KHz
2	432 KHz
4	864 KHz
8	1728.05 KHz
16	3456.15 KHz

If an indication is abnormal, check the associated bandpass filter and switching circuit on card A2A9. If all indications are abnormal, troubleshoot the first IF mixer circuitry on card A2A9. (Ref. paragraph 4.3.4.3.)

h. Connect the frequency counter between test jack TP3 on card A2A9 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the frequency indication on the counter for each position. Normal indications are as follows:

Switch A1S2 Position	Counter Indication
1	200 KHz
2	400 KHz
4	800 KHz
8	1.6 MHz
16	3.2 MHz

If indications are abnormal, proceed to step o.

i. Connect the frequency counter between front panel test jacks A1TP3 (BP OUT) and A1TP4 (GRD). Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the frequency indication on the counter for each position. Normal indications are as follows:

Switch A1S2 Position	Counter Indication
1	16 KHz
2	32 KHz
4	64 KHz
8	128.05 KHz
16	256.15 KHz

If an indication is abnormal, troubleshoot the applicable bandpass filter and switching circuit on card A2A10. If all indications are abnormal, troubleshoot the second IF mixer and mixer amplifier circuits on card A2A9. (Ref. paragraph 4.3.4.3.)

If all indications to this point are normal, the circuits associated with tuning the Model 4145 to a selected channel are functioning properly.

j. Connect a DC voltmeter to test jack TP3 on card A2A7. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the voltage indication for each position. Normal indications are as follows:

Switch A1S2 Position	Voltmeter Indication
1	+2.1 ±0.5V
2	−2.8 ±0.5V
4	−2.2 ±0.5V
8	−1.9 ±0.5V
16	−1.8 ±0.5V

If indications are out of tolerance, perform the VCO modulator checkout and adjustment procedure outlined in paragraph 5.3.6.

k. Connect the frequency counter between test jack TP4 on card A2A6 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the frequency indication for each position. Normal indications are as follows:

Switch A1S2 Position	Counter Indication
1	419.2 KHz
2	502.4 KHz
4	492.8 KHz
8	487.95 KHz
16	485.45 KHz

If indications are abnormal, troubleshoot the 450 KHz bandpass filter on card A2A6 and the 450 KHz VCO circuits on card A4A1A1 in the oven assembly. (Ref. paragraph 4.3.3.5.)

l. Connect the frequency counter between test jack TP1 on card A2A6 and ground. The counter should indicate 2 MHz ±1 Hz. If indication is slightly out of tolerance, adjust capacitor C7 on card A4A1A2 in the oven assembly to obtain the proper indication. If the indication is excessively in error, troubleshoot the 12.8 MHz crystal oscillator circuits on card A4A1A2 in the oven assembly and on card A2A5. (Ref. paragraphs 4.3.3.2 and 4.3.3.3.)

m. Connect the frequency counter between test jack TP2 on card A2A6 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the frequency indication for each position. Normal indications are as follows:

Switch A1S2 Position	Counter Indication
1	2419.2 KHz
2	2502.4 KHz
4	2492.8 KHz
8	2487.95 KHz
16	2485.45 KHz

If the indications are abnormal, troubleshoot the 2.45 MHz bandpass filter and summing mixer M1 circuits on card A2A6. (Ref. paragraph 4.3.3.6.)

n. Connect the frequency counter between test jack TP3 on card A2A6 and ground. Sequentially set DEVIATION (±kHz) switch A1S2 to each deviation range and observe the frequency indication for each position. Normal indications are as follows:

Switch A1S2 Position	Counter Indication
1	7475.2 KHz
2	6758.4 KHz
4	6348.8 KHz
8	6144.0 KHz
16	6041.6 KHz

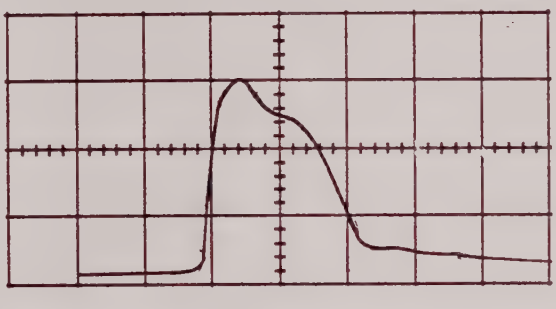
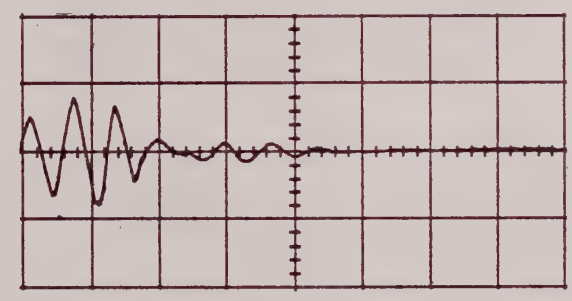
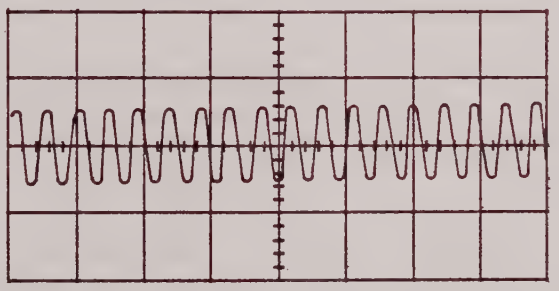
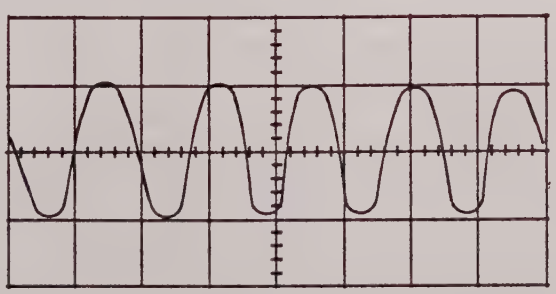
If indications are abnormal, proceed as follows:

1. Connect the Tektronic 545A oscilloscope to the base of transistor Q13 on card A2A5. The displayed waveform should be as shown in waveform A of Table 5-1. If indication is abnormal, troubleshoot the divide-by-125 circuit and the 102.4 KHz comb generator on card A2A5. (Ref. paragraph 4.3.3.3.)

2. Connect the oscilloscope to test jack TP2 on card A2A5. The displayed signal should be as shown in waveform B of Table 5-1. If the indication is abnormal, troubleshoot the 6.8 MHz bandpass filter circuit on card A2A5. (Ref. paragraph 4.3.3.3.)

3. Connect the oscilloscope to test jack TP1 on card A2A5. The displayed

Table 5-1. Harmonic Selector Card A2A5 Test Waveforms

CIRCUIT LOCATION	INPUT	WAVEFORM	OSCILLOSCOPE	
			VERT.	HORIZ.
Base of Q13 on card A2A5.			5V/Cm	10ns/Cm
A2A5TP2			5V/Cm	0.2µs/ Cm
A2A5TP1			.5V/Cm	0.1µs/ Cm
A2A6TP3			.2V/Cm	0.1µs/ Cm

signal should be as shown in waveform C of Table 5-1. If the indication is abnormal, troubleshoot the 20 MHz amplifier circuit (Z8/Q1), filter FL1, mixer A1, and the harmonic selector circuits on card A2A5 (ref. paragraph 4.3.3.3) and the coarse data encoder circuit on card A2A4. (Ref. paragraph 4.3.3.)

4. Connect the oscilloscope to test jack TP3 on card A2A6. The displayed signal should be as shown in waveform D of Table 5-1. If indication is abnormal, troubleshoot the 6.8 MHz bandpass filter on card A2A6 (paragraph 4.3.3.6), and mixer A2 and the output amplifier circuit (Q6/Q7) on card A2A5. (Ref. paragraph 4.3.3.3.)

o. Connect the frequency counter to pin 5 of card A2A5. The counter should indicate 6.4 MHz ±20 Hz. If indication is abnormal, troubleshoot buffer amplifier Q1 and the first divide-by-2 stage on card A2A5. (Ref. paragraph 4.3.3.3.) If indication is normal, troubleshoot the counter control (Z33 and Z34), binary divider (Z28 thru Z32) and differential amplifier (Q13 and Q14) on card A2A9. (Ref. paragraph 4.3.4.3.)

p. Connect the frequency counter to pin 2 of card A2A5. The counter should indicate 400 KHz ±1.0 Hz. If indication is abnormal, troubleshoot buffer amplifier Q2 and divide-by-2 stage on card A2A5.

q. Connect the frequency counter to pin 11 of card A2A5. The counter should indicate 100 KHz ±1.0 Hz. If indication is abnormal, troubleshoot buffer amplifier Q4 and the divide-by-2 stage on card A2A5.

5.3.5 Deviation Sensitivity Checkout and Adjustment Procedure

The following procedure is designed to check the operation of detector card A2A11 and the output circuits (single pole card A2A12, pole pair cards A2A13 and A2A14, and regulator/output amplifier card A2A15) of the Model 4145 with center frequency inputs and full bandedge deviation. Where applicable, instructions are provided for adjusting abnormal output indication to within acceptable limits. References are provided in the procedural instructions to applicable circuit descriptions in Section 4 in the event troubleshooting is deemed necessary.

Perform the deviation sensitivity checkout procedure as follows:

a. On the rear panel of the Model 4145, connect the 100 KHz test signal (connector A3J4) to INPUT connector A3J3 and connect the grounding cap to TSC connector A3J2.

b. Set the Model 4145 front panel controls as follows:

Control	Position
CENTER FREQUENCY (kHz) Switches A1S3 thru A1S7	0100.0
DEVIATION (±kHz) Switch A1S2	4
DATA CUTOFF Switches A1S9 thru A1S12	010. Hz
LPOF switch A1S8	CD
BANDEDGE volts potentiometer A1R1	Fully Clockwise
SENSE Switch S14	(-)

c. Connect the Hewlett-Packard 5245L frequency counter to test jack TP1 on card A2A9. The counter should indicate 964 KHz. If indication is abnormal, perform the tuning accuracy procedure outlined in paragraph 5.3.4.

d. Remove detector card A2A11 from the card file chassis assembly.

e. On single pole card A2A12 ground pins 33 and 34.

f. Connect the Fluke 825A DC voltmeter to test jack TP1 on card A2A12. The voltmeter should indicate 0 volts ±10 millivolts. If indication is abnormal, adjust operational amplifier Z1 on card A2A12 as follows:

1. While alternately grounding and removing the ground from test jack TP2 on card A2A12, adjust potentiometer A2A12R13 to the point at which any voltage variation, as indicated on the voltmeter, is minimized.

2. Adjust potentiometer A2A12R19 for a 0 volt ±10 millivolt indication on the voltmeter.

3. Repeat steps 1 and 2 until no further adjustments are necessary.

Refer to paragraph 4.3.5 for the circuit description of single pole card A2A12 if troubleshooting is deemed necessary.

g. Connect the DC voltmeter to terminal E3 on card A2A13. The voltmeter should indicate 0 volts ±10 millivolts. If indication is abnormal, adjust operational amplifier Z1 on card A2A13 as follows:

1. While alternately grounding and removing the ground from terminal E5 on card A2A13, adjust potentiometer A2A13R15 to the point at which any voltage variations, as indicated on the voltmeter, are minimized.

2. Adjust potentiometer A2A13R33 for a 0 volt ±10 millivolt indication on the voltmeter.

3. Repeat steps 1 and 2 until no further adjustments are necessary.

h. Connect the DC voltmeter to test jack TP2 on card A2A13. The voltmeter should indicate 0 volts ±10 millivolts. If indication is abnormal, adjust operational amplifier Z2 on card A2A13 as follows:

1. While alternately grounding and removing the ground from terminal E8 on card A2A13, adjust potentiometer A2A13R37 to the point at which any voltage variations, as indicated on the voltmeter, are minimized.

2. Adjust potentiometer A2A13R45 for a 0 volt ±10 millivolt indication on the voltmeter.

3. Repeat steps 1 and 2 until no further adjustments are necessary.

Refer to paragraph 4.3.5 for the circuit description of pole pair cards A2A13 and A2A14 if troubleshooting is deemed necessary.

i. Repeat steps h. and i. for pole pair card A2A14.

j. Connect the DC voltmeter to test jack TP9 on card A2A15. The voltmeter should indicate 0 volts ±10 millivolts. If indication is abnormal, adjust potentiometer R25 on card A2A15 to obtain proper indication. Refer to paragraph 4.3.5 for circuit description of the output amplifier if troubleshooting is deemed necessary.

k. Remove the ground from pins 33 and 34 of card A2A12 and replace detector card A2A11 in the card file chassis assembly.

l. Connect the DC voltmeter to front panel test jack TP2 (DATA OUT).

NOTE

If the test results of steps n. through r. indicate a circuit failure, refer to paragraph 4.3.5.5 for circuit description of detector card A2A11.

m. Set DEVIATION (±kHz) switch A1S2 to position 1. The voltmeter should indicate 0 volts ±200 millivolts. If indication is abnormal, adjust potentiometer R68 on detector card A2A11 for required output level.

n. Set DEVIATION (±kHz) switch A1S2 to position 2. The voltmeter should indicate 0 volts ±200 millivolts. If indication is abnormal, adjust potentiometer R67 on card A2A11 to obtain required output level.

o. Set DEVIATION (±kHz) switch A1S2 to position 4. The voltmeter should indicate 0 volts ±200 millivolts. If indication is abnormal, adjust potentiometer R65 on card A2A11 to obtain required output level.

p. Set DEVIATION (±kHz) switch A1S2 to position 8. The voltmeter should indicate −63 ±200 millivolts. If indication is abnormal, adjust potentiometer R63 on card A2A11 to obtain required output level.

q. Set DEVIATION (±kHz) switch A1S2 to position 16. The voltmeter should indicate −94 ±20 millivolts. If indication is abnormal, adjust potentiometer R62 to obtain required output level.

r. Adjust the gain of the output amplifier circuit as follows:

1. Connect the Waveforms 401 signal generator to TSC connector A3J2 on the rear panel, and adjust the signal generator for a 100 Hz output with an amplitude of 1.00 volts RMS.

2. On the front panel, adjust BANDEDGE VOLTS potentiometer A1R1 to midrange.

3. Connect the Hewlett-Packard 4001 RMS meter to DATA OUT test jack A1TP2 on the front panel and record the output indication.

4. On the front panel, set SENSE switch A1S14 to (+) and observe the RMS meter indication. The indication should be the same as that recorded in step (3). If indication is abnormal, adjust potentiometer R83 on card A2J15 to obtain proper indication.

s. Remove the signal generator from TSC connector A3J2 and replace the grounding cap.

t. Set DEVIATION (±kHz) switch A1S2 to position 1.

u. Set CENTER FREQUENCY (kHz) switches A1S3 thru A1S7 to 0099.0.

v. Rotate BANDEDGE VOLTS potentiometer A1R1 and observe that the voltmeter indication varies smoothly from 0 to +10 volts. At the +10 volt level, front panel BANDEDGE meter A1M2 should indicate upper bandedge.

w. Lock BANDEDGE VOLTS potentiometer A1R1 at the +10 volt level.

x. On the front panel, set SENSE switch A1S14 to (−). The output voltage indication observed on the voltmeter should switch from +10 volts to −10 volts.

5.3.6 VCO Modulator Checkout and Adjustment Procedure

To check and adjust the fine tuning and tape speed compensation circuits (VCO modulator) on card A2A7, proceed as follows:

NOTE

Before proceeding with this procedure, verify that the Model 4145 is calibrated for full bandedge deviation as described in paragraph 5.3.5.

a. On the rear panel of the Model 4145, connect the 100 KHz test signal (connector A3J4) to INPUT connector A3J3 and connect the grounding cap to TSC connector A3J2.

b. Set the Model 4145 front panel controls as follows:

Control	Position
CENTER FREQUENCY (kHz) Switches A1S3 thru A1S7	0100.0
DEVIATION (±kHz) Switch A1S2	4
DATA CUTOFF Switches A1S9 thru A1S12	500 Hz
LPOF switch A1S8	CA
CONTROL switch A1S1	LOCAL
BALANCE pot. A1R2	Midrange

c. Connect the Fluke 825A DC voltmeter to test jack TP4 on card A2A7 and adjust potentiometer A2A7R57 for a 0 millivolt indication.

d. Connect the DC voltmeter to test jack TP2 and adjust potentiometer A2A7R53 for a 0 millivolt indication.

e. Connect the DC voltmeter to test jack TP1 on card A2A7 and adjust potentiometer A2A7R13 for a 0 millivolt indication.

f. Connect the Hewlett-Packard 5245L frequency counter to test jack TP4 on card A2A6.

g. Alternately set the front panel CENTER FREQUENCY (kHz) switches to 0045.5 and 0045.6 while adjusting potentiometer A2A7R72 to the point at which the change in the counter indication from one setting to the other is precisely 102.0 KHz.

NOTE

The counter indication should be approximately 505 ±5 KHz with the CENTER FREQUENCY switches set to 0045.5 and 403 ±5 KHz with the switches set to 0045.6.

h. Adjust the front panel BALANCE potentiometer A1R2 to the point at which the 102.0 difference of step g. is centered between 403.6 KHz and 505.6 KHz. Repeat step g. to verify that the change is still precisely 102.0 KHz. If normal output indication cannot be attained, troubleshoot the fine tuning circuitry on card A2A7. (Reference paragraph 4.3.3.4 for circuit description.)

NOTE

With aging, the balance circuitry may drift toward the + end. The balance circuitry may be recentered for midrange operation of BALANCE potentiometer A1R2 by readjusting the +12 volt reference regulator in the oven assembly as required.

i. Set the front panel CENTER FREQUENCY switches to 0100.0.

j. On the rear panel, connect the Hewlett-Packard 200CD Signal Generator to TSC connector A3J2. Adjust the signal generator for a 100 Hz signal with an amplitude of 4 volts peak (2.828V RMS).

k. Connect the Hewlett-Packard 400L RMS meter to DATA OUT test jack TP2 on the front panel. The meter should indicate approximately 5.3025 volts RMS. If indication is abnormal, adjust TSC gain potentiometer A2A7R70. If normal indication cannot be attained, troubleshoot the tape speed compensation circuitry on card A2A7. (Reference paragraph 4.3.3..4 for circuit description.)

5.4 LUBRICATING INSTRUCTIONS FOR ROTRON MUFFIN FAN

For best long life performance, the Rotron muffin fan should be oiled at least once a year. In installations of unusually severe service or environment, oiling should be more frequent. Oiling should be performed using Rotron Oiler Kit No. 19263. Refill bottles No. 19263-4 may be purchased separately. Oiling instructions to inject oil into the bearings are as follows:

a. Position the needle at an angle of 45° to the seal on the label.

b. Pierce label and concealed self-sealing rubber cap under the label in letter "O" in oil.

c. Depress plunger firmly until oil has gone down one calibration line.

d. Withdraw the needle and wipe off excess oil. Oil may be left in the syringe for future use.

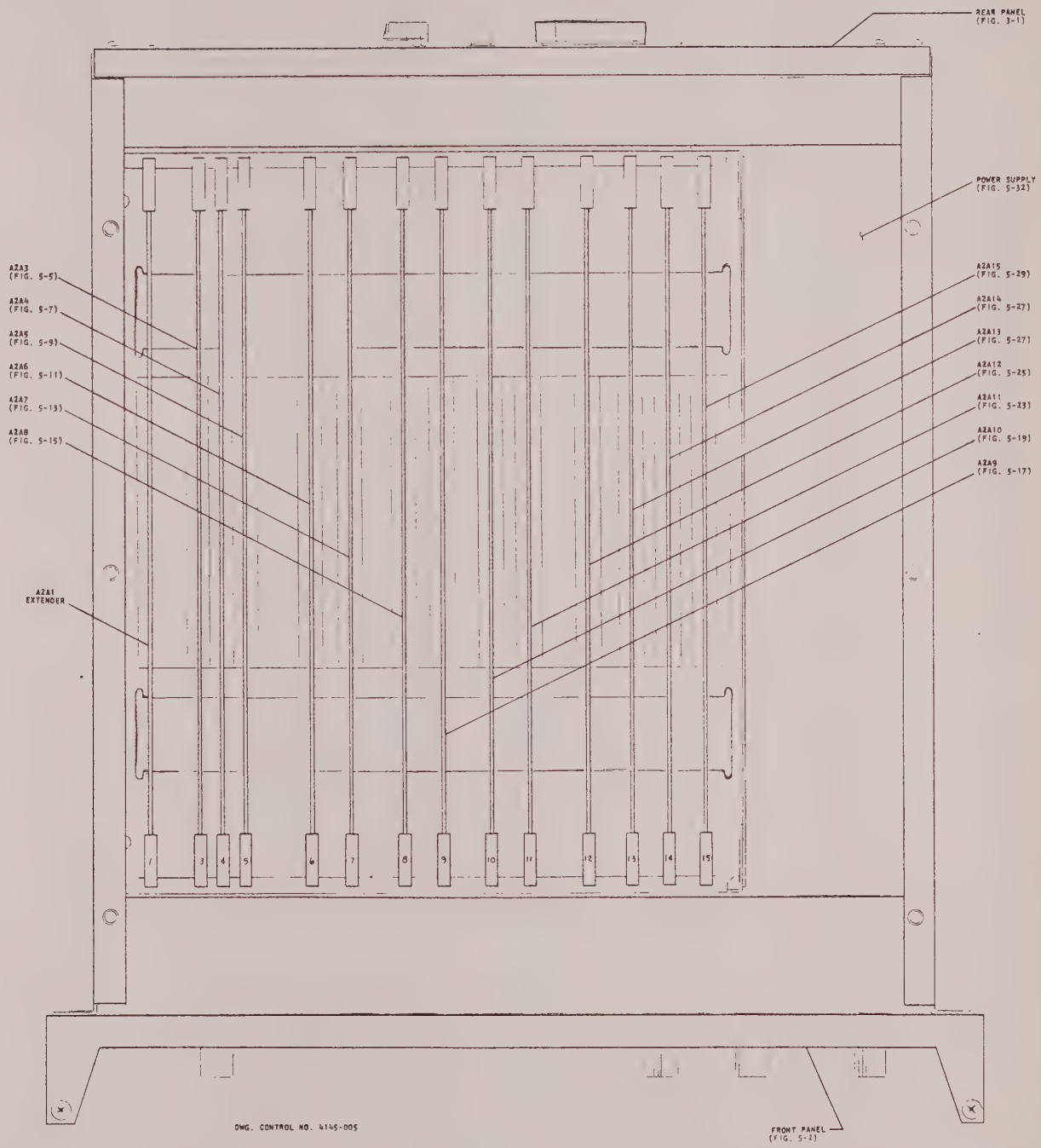
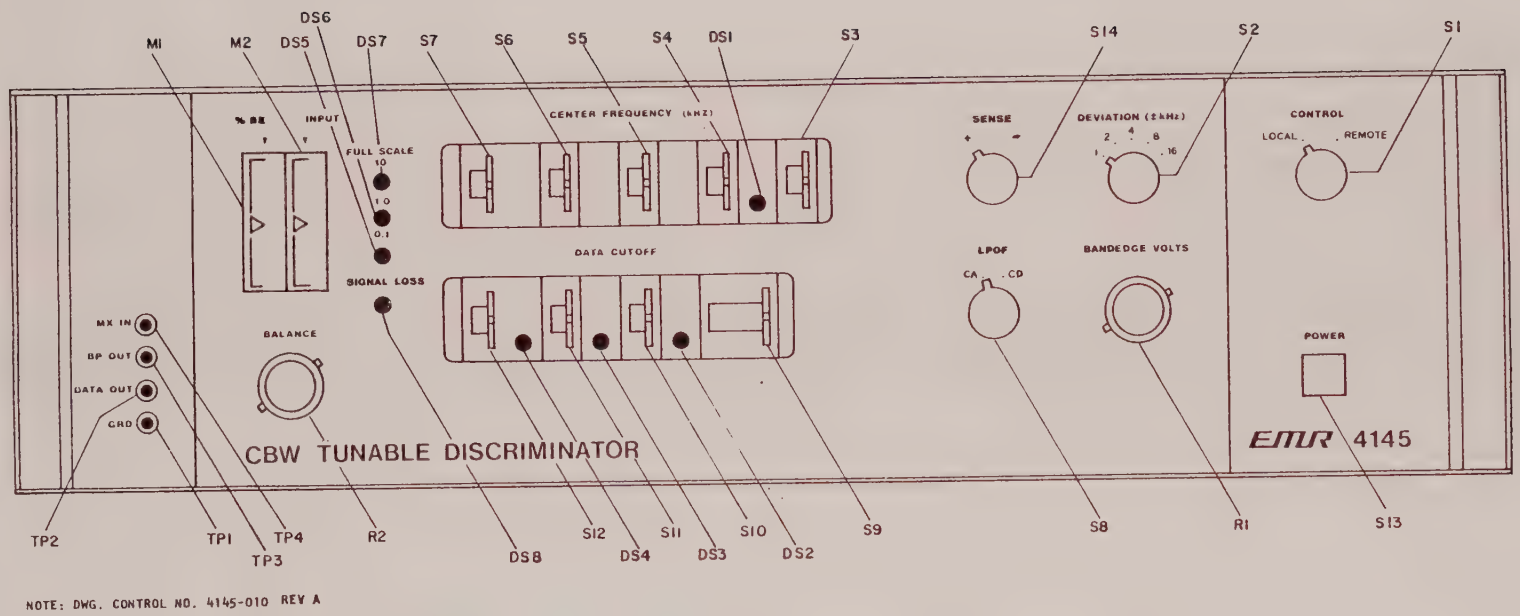


Figure 5-1. Model 4145 CBW Tunable Discriminator Assembly Diagram



NOTE: DWG. CONTROL NO. 4145-010 REV A

Figure 5-2. Front Panel Assembly A1 Location of Components

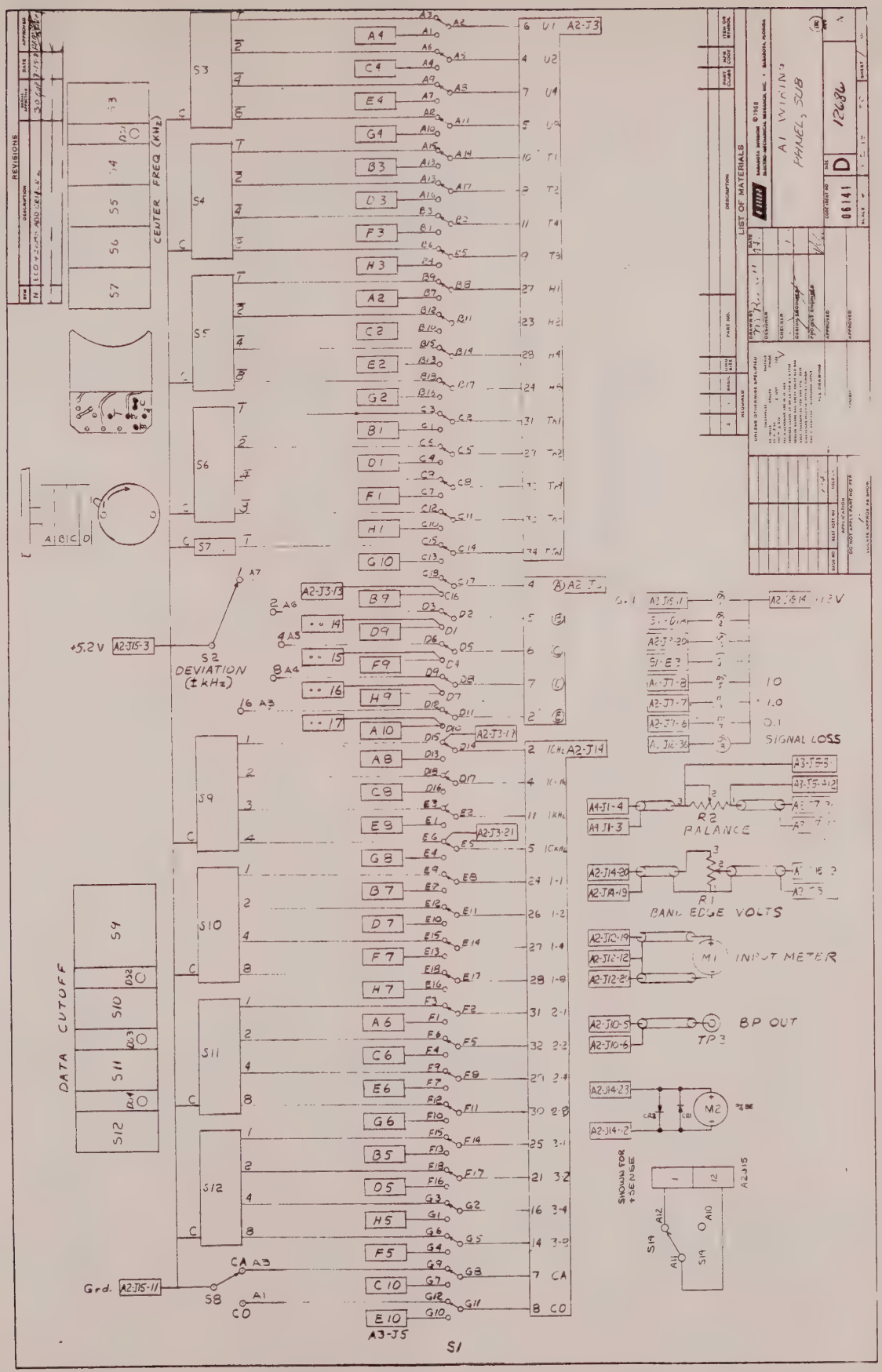
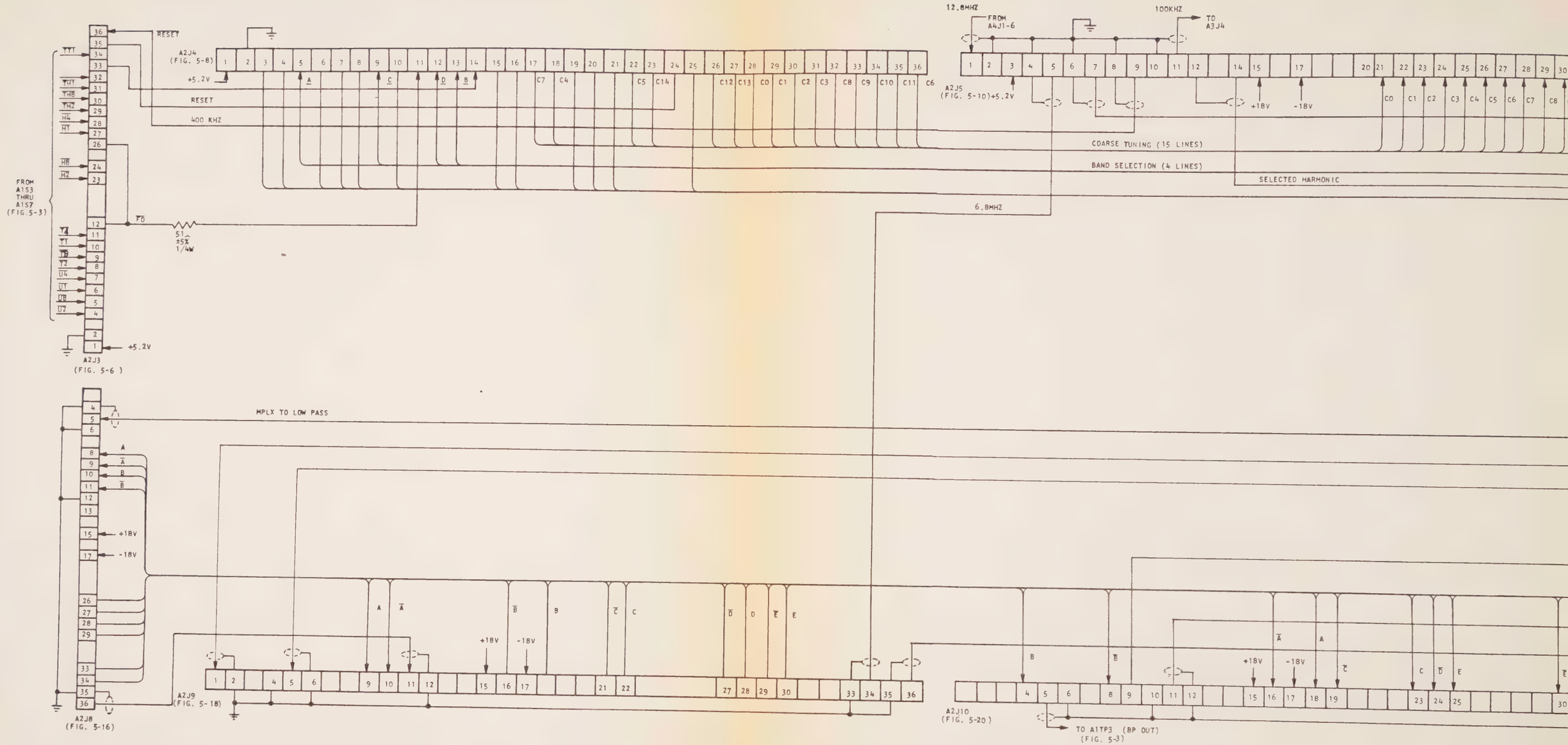
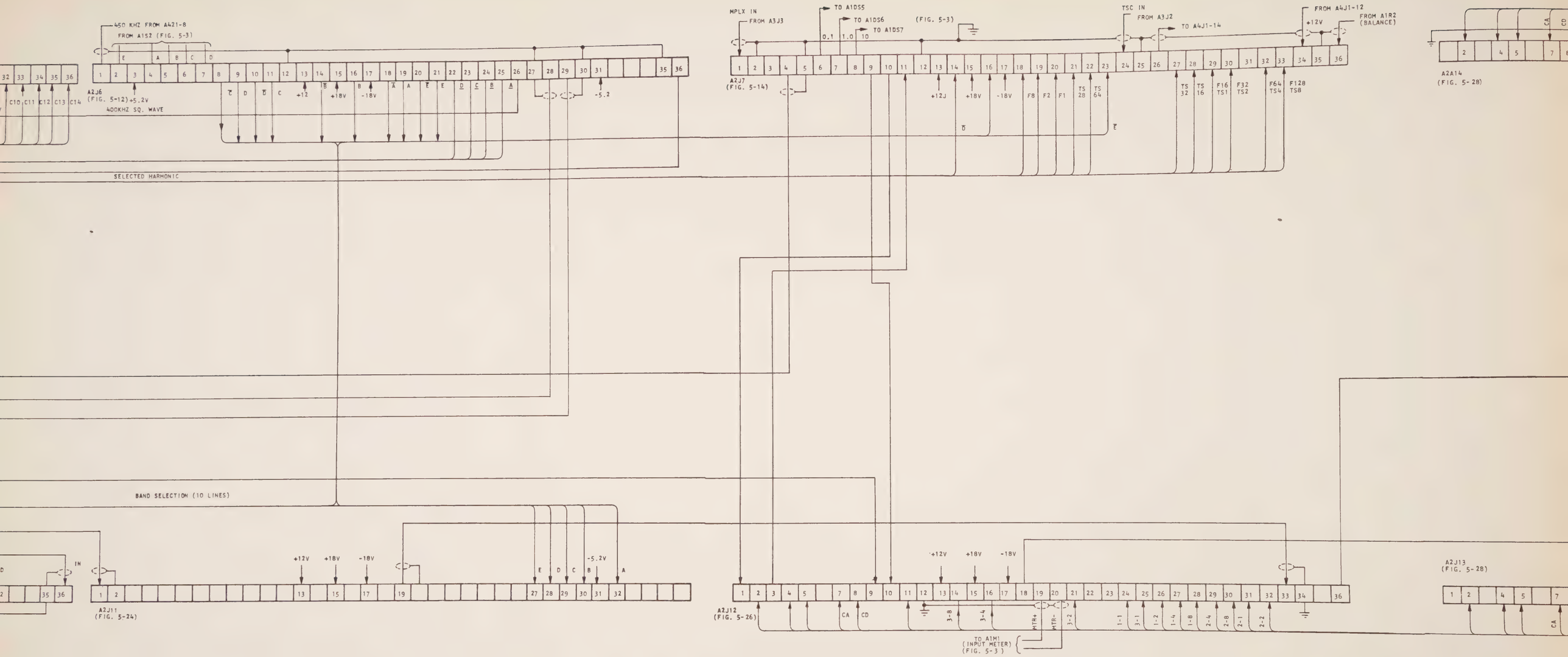


Figure 5-3. Front Panel Assembly A1 Schematic Wiring Diagram


FROM A1S3 THRU A1S7 (FIG. 5-3)
RESET
A2J4 (FIG. 5-8)
+5.2V
RESET
400 KHZ
FO
51Ω ±5% 1/4W
A2J3 (FIG. 5-6)
12.8MHZ
FROM A4J1-6
100KHZ
TO A3J4
A2J5 (FIG. 5-10)+5.2V
+18V
-18V
COARSE TUNING (15 LINES)
BAND SELECTION (4 LINES)
SELECTED HARMONIC
6.8MHZ
MPLX TO LOW PASS
A2J8 (FIG. 5-16)
A2J9 (FIG. 5-18)
A2J10 (FIG. 5-20)
TO A1TP3 (BP OUT) (FIG. 5-3)


450 KHZ FROM A421-8
FROM A1S2 (FIG. 5-3)
A2J6
(FIG. 5-12)
+5.2V
400KHZ SQ. WAVE
+12
+18V
-18V
-5.2
SELECTED HARMONIC
BAND SELECTION (10 LINES)
MPLX IN
FROM A3J3
TO A1DS5
TO A1DS6
TO A1DS7
(FIG. 5-3)
A2J7
(FIG. 5-14)
TSC IN
FROM A3J2
TO A4J1-14
FROM A4J1-12
+12V
FROM A1R2
(BALANCE)
+12J
F8
F2
F1
TS 28
TS 64
TS 32
TS 16
F16 TS1
F32 TS2
F64 TS4
F128 TS8
A2A14
(FIG. 5-28)
IN
A2J11
(FIG. 5-24)
A2J12
(FIG. 5-26)
A2J13
(FIG. 5-28)
TO A1M1
(INPUT METER)
(FIG. 5-3)

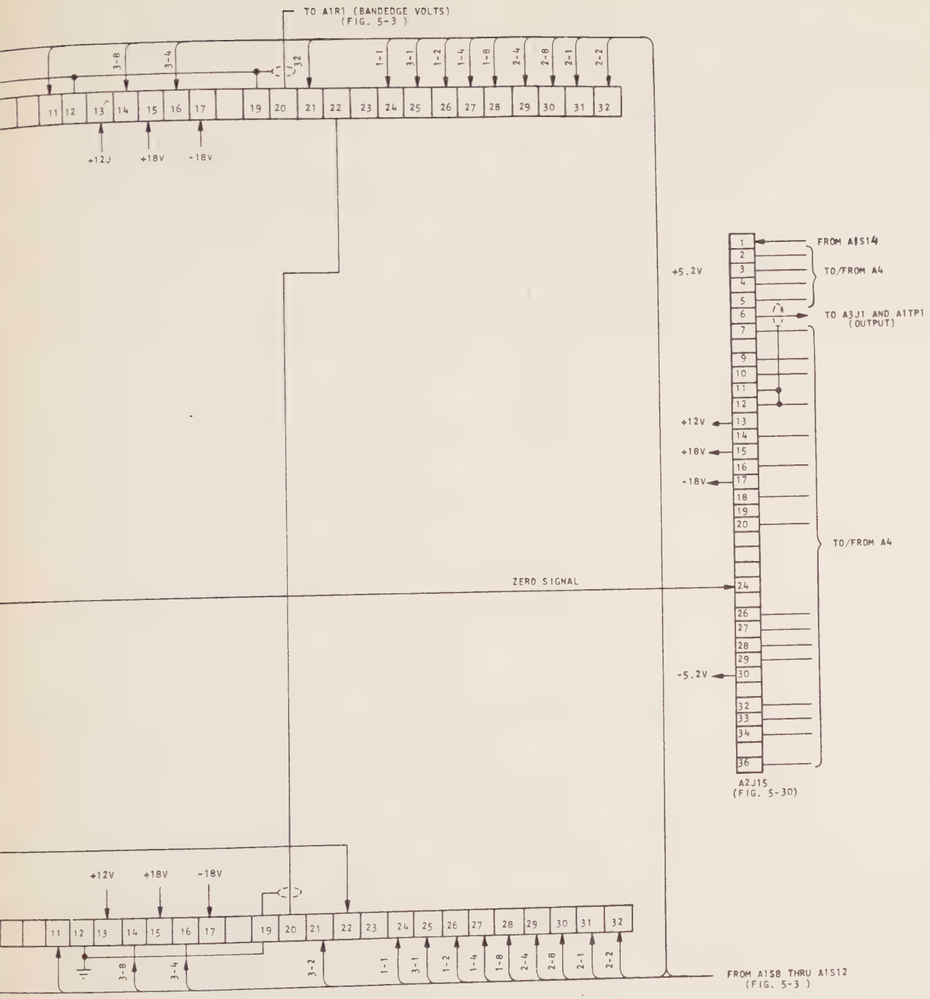
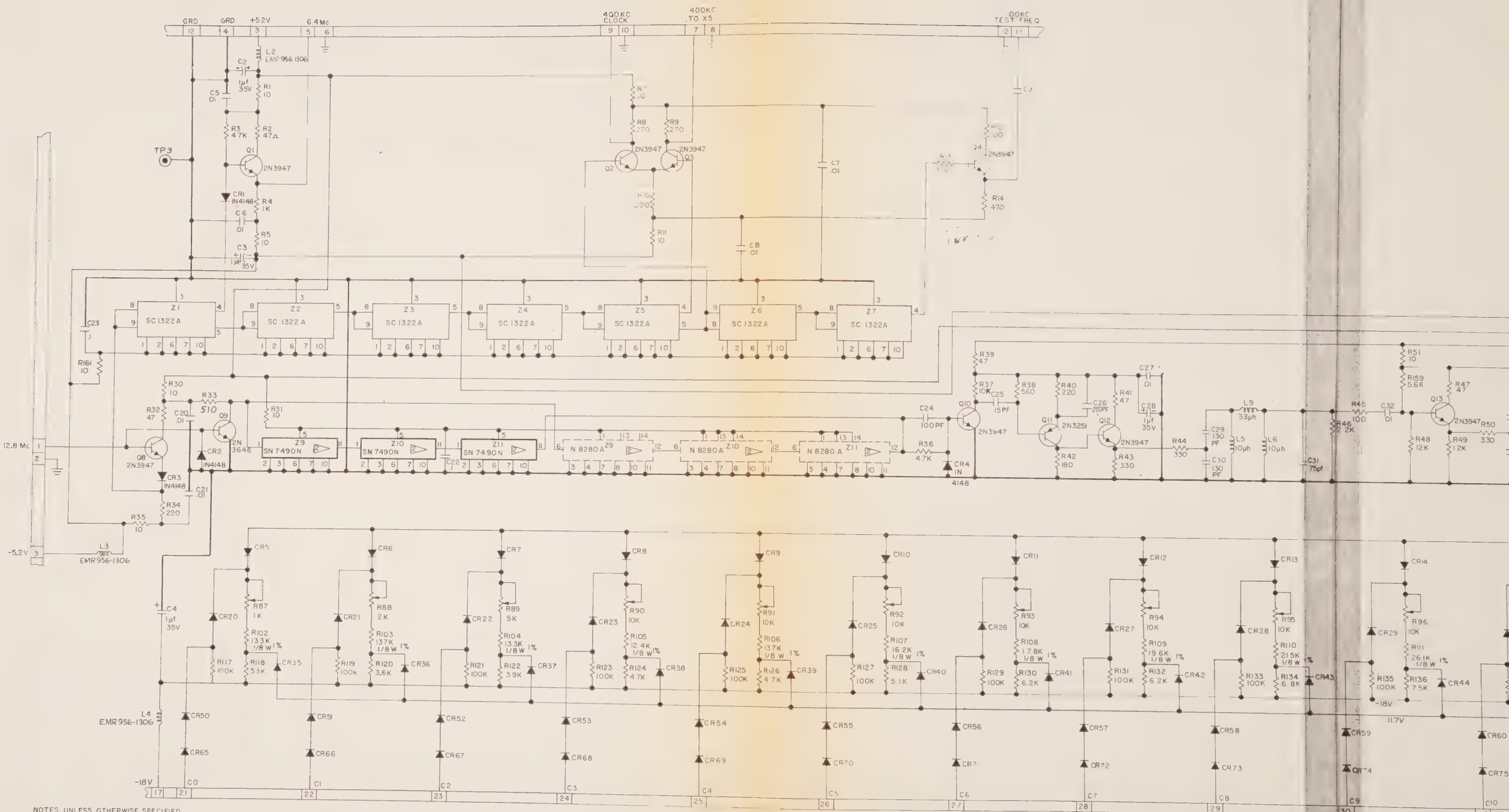


Figure 5-4. Card File Chassis A2
Wiring Diagram



NOTES UNLESS OTHERWISE SPECIFIED

1. C49 AND C55 ARE TEMPERATURE COMPENSATING CAPACITORS. ONE OR BOTH MAY BE USED THEY MAY BE ANY 708-0000-1 BUT WILL PROBABLY BE ONE OF THE FOLLOWING. 708-0147-1, 6.8pf N900 ; 708-0148-1, 6.8pf N1400 ; 708-0149-1, 6.8pf N2200, 708-0168-1, 10 pf N1400.
2. FOR Z9, Z10 & Z11 USE SN7490N TYPE IN HEAVY OUT LINE, IF NOT AVAIABLE SUBSTITUTE TYPE N 8280 A IN DOTTED OUTLINE ONLY.
3. ALL DIODES IN4148
4. ALL RESISTOR VALUES IN OHMS. (K=1000)
5. ALL CAPACITOR VALUES IN UF
6. EMR DWG. NO. 15168, REV. D

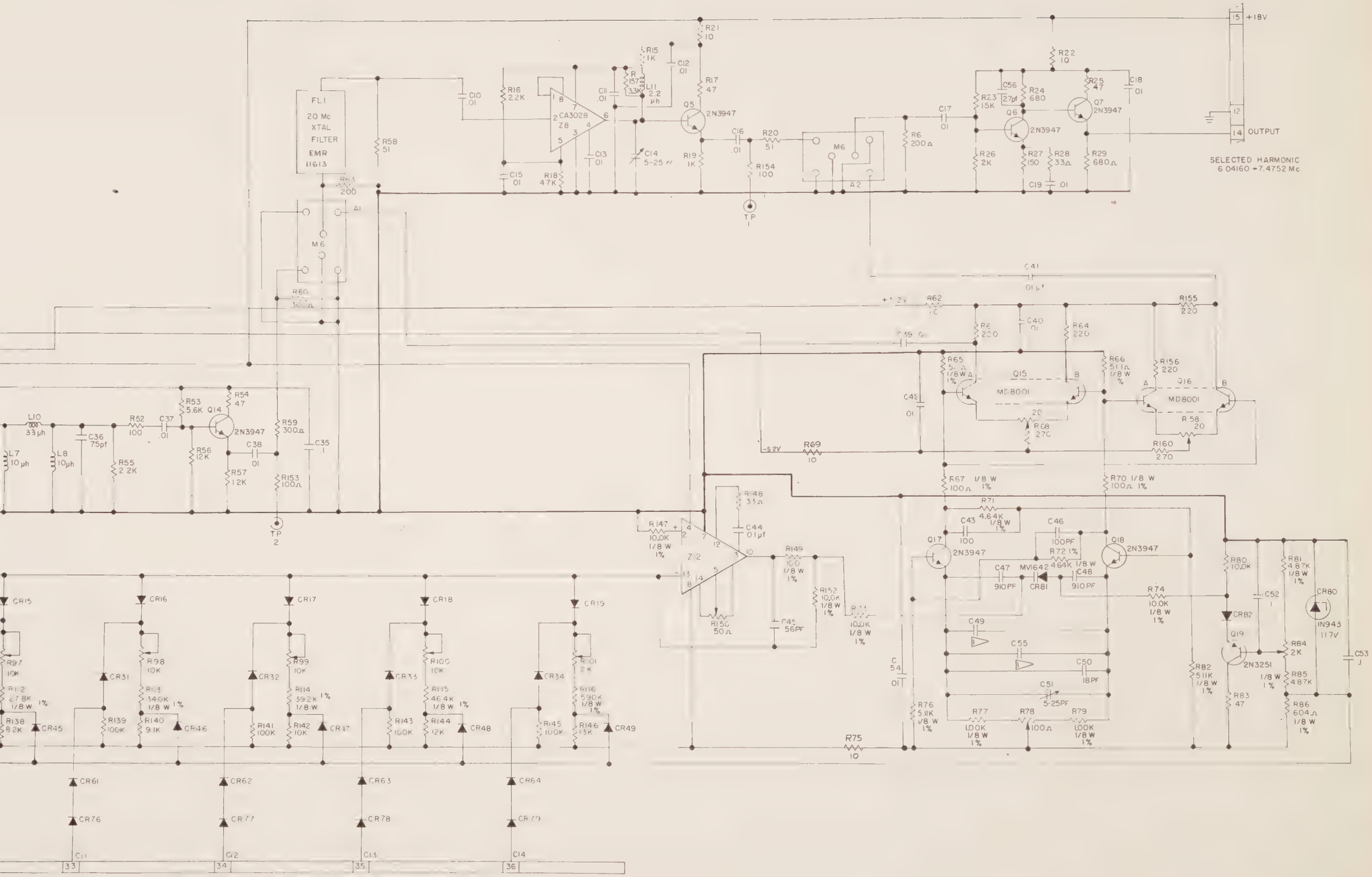


Figure 5-10. Model 4145 Harmonic Selector Card A2A5 Schematic Diagram

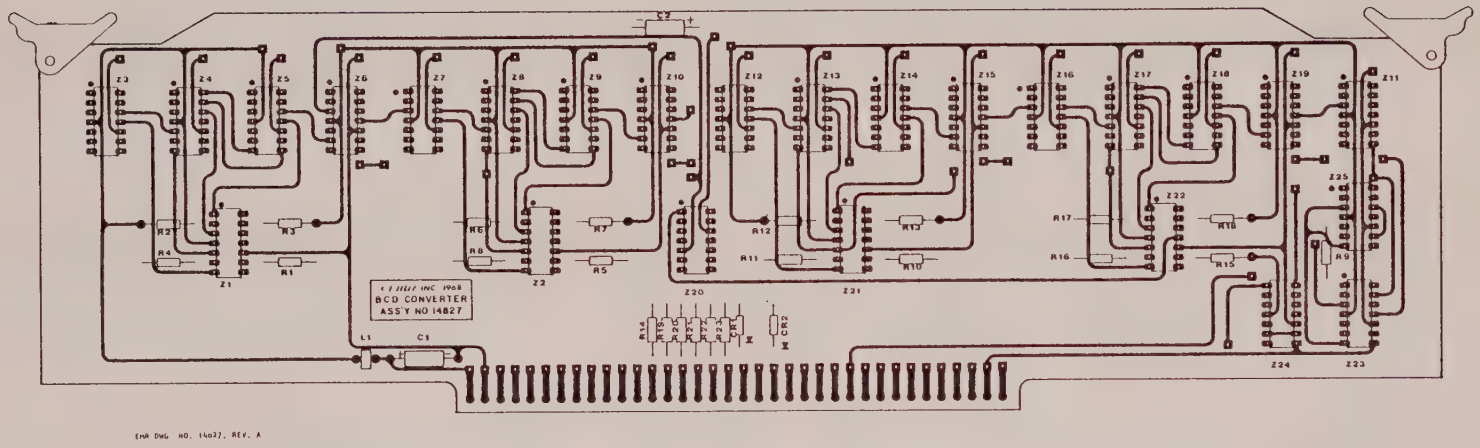


Figure 5-5. BCD Converter Card A2A3 Location of Components

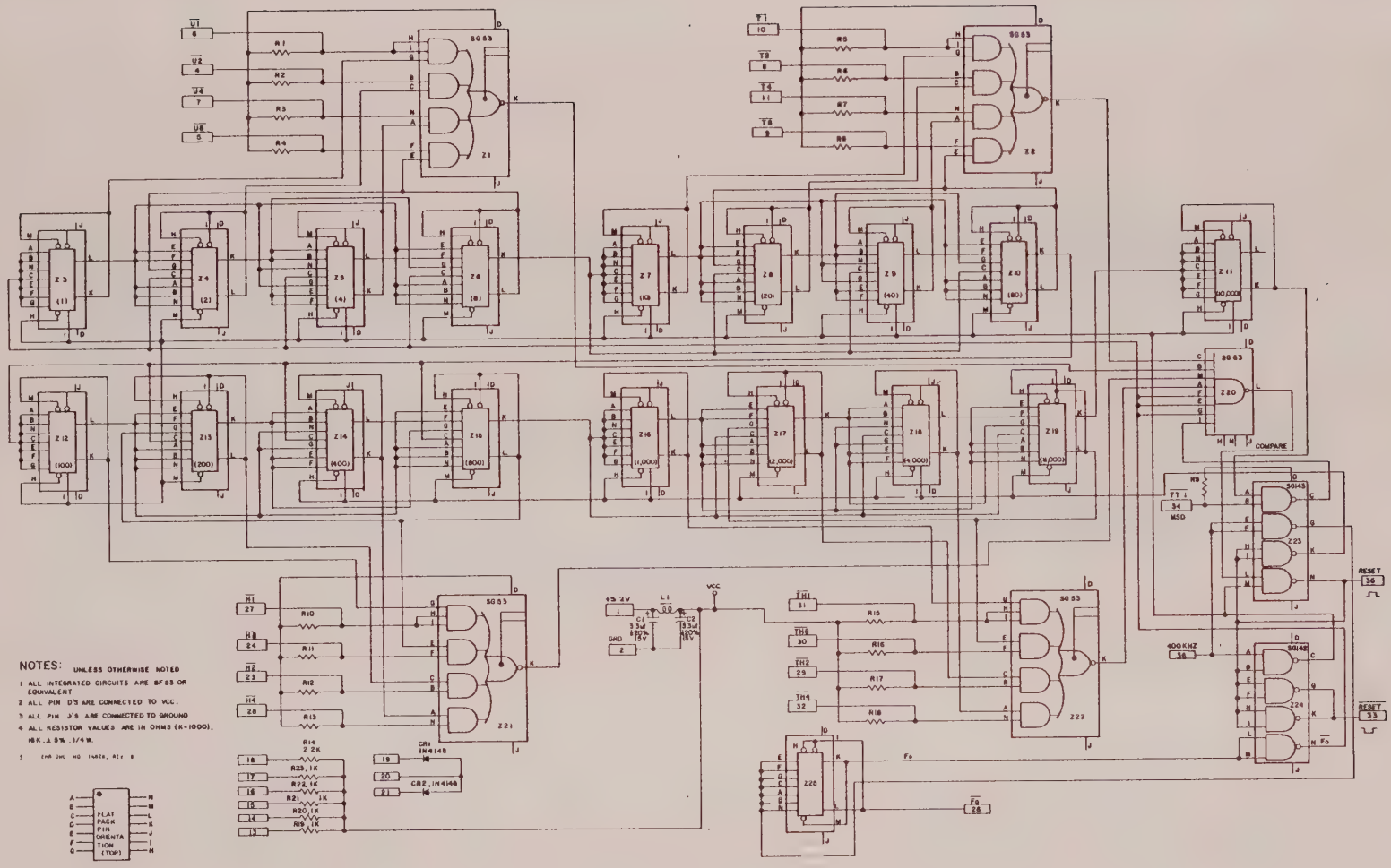


Figure 5-6. BCD Converter Card A2A3 Schematic Diagram

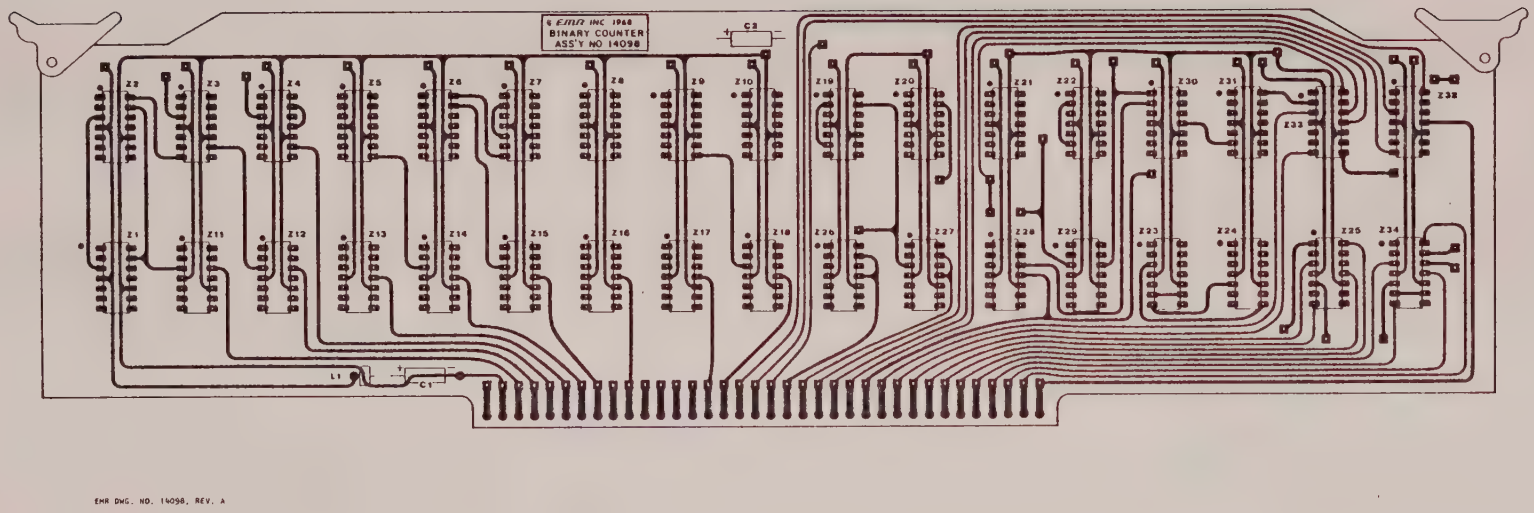


Figure 5-7. Binary Counter Card A2A4 Location of Components

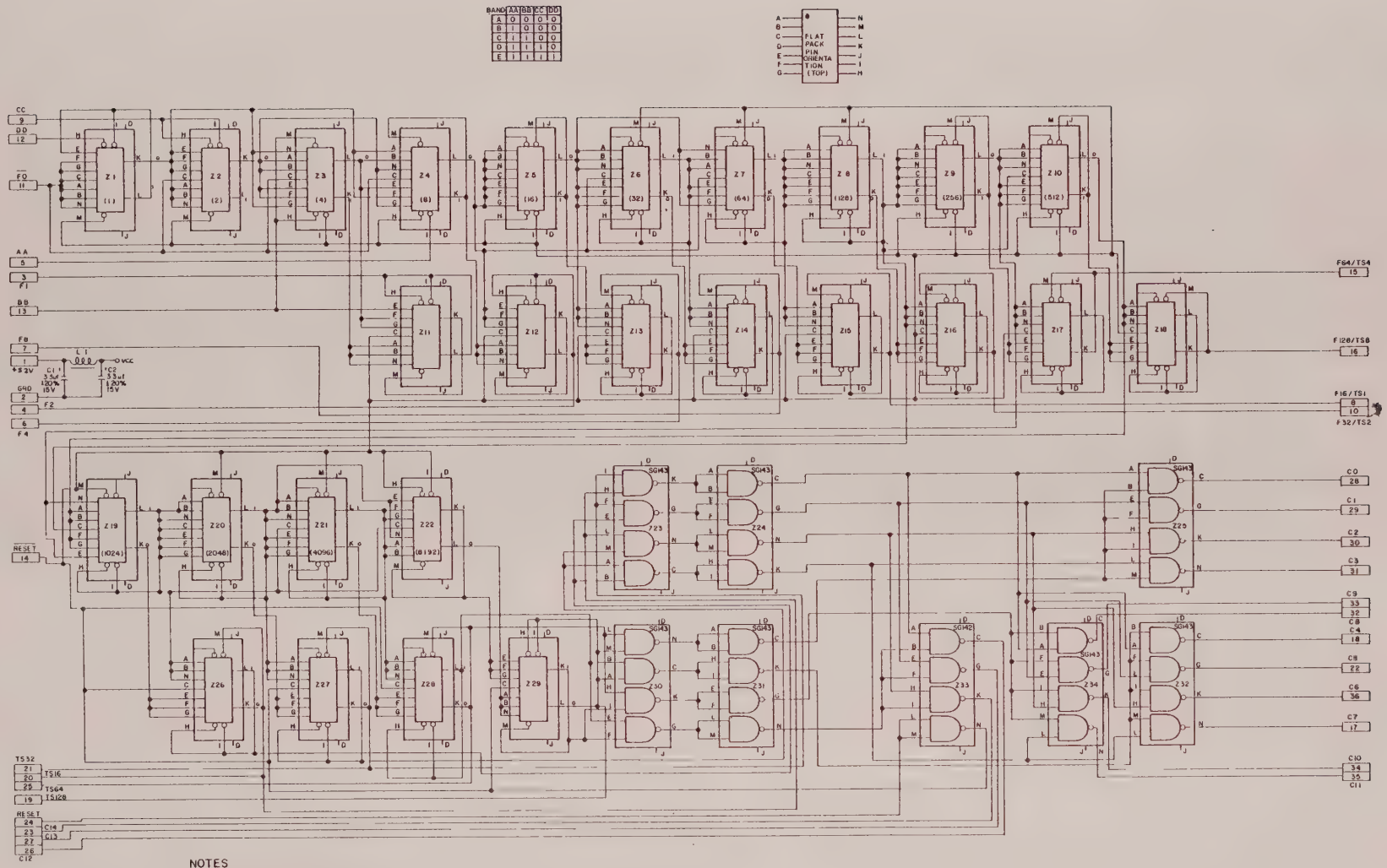


Figure 5-8. Binary Counter Card A2A4 Schematic Diagram

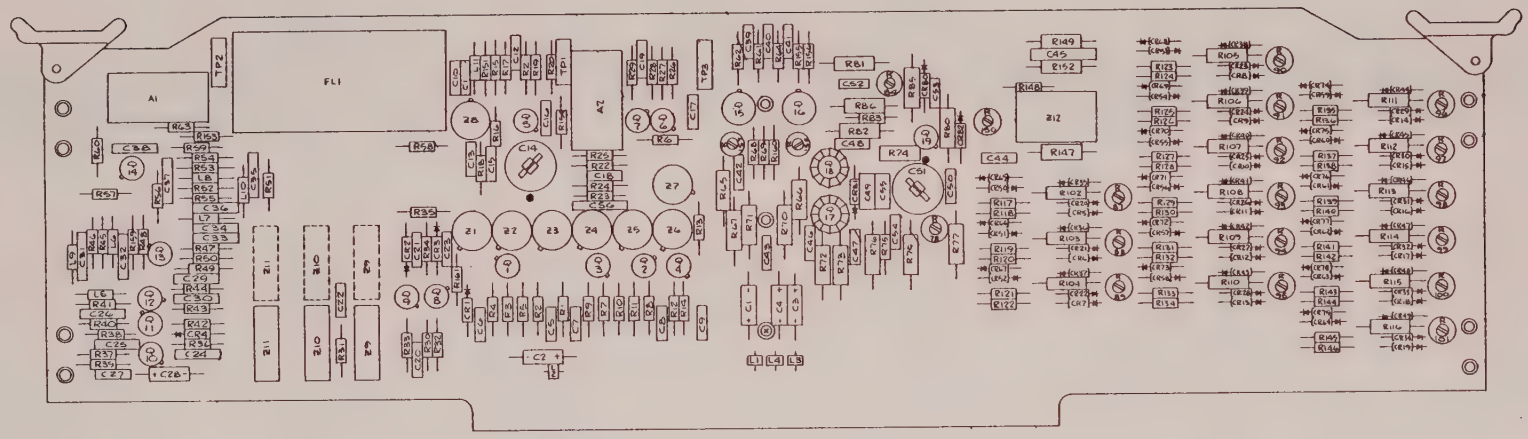
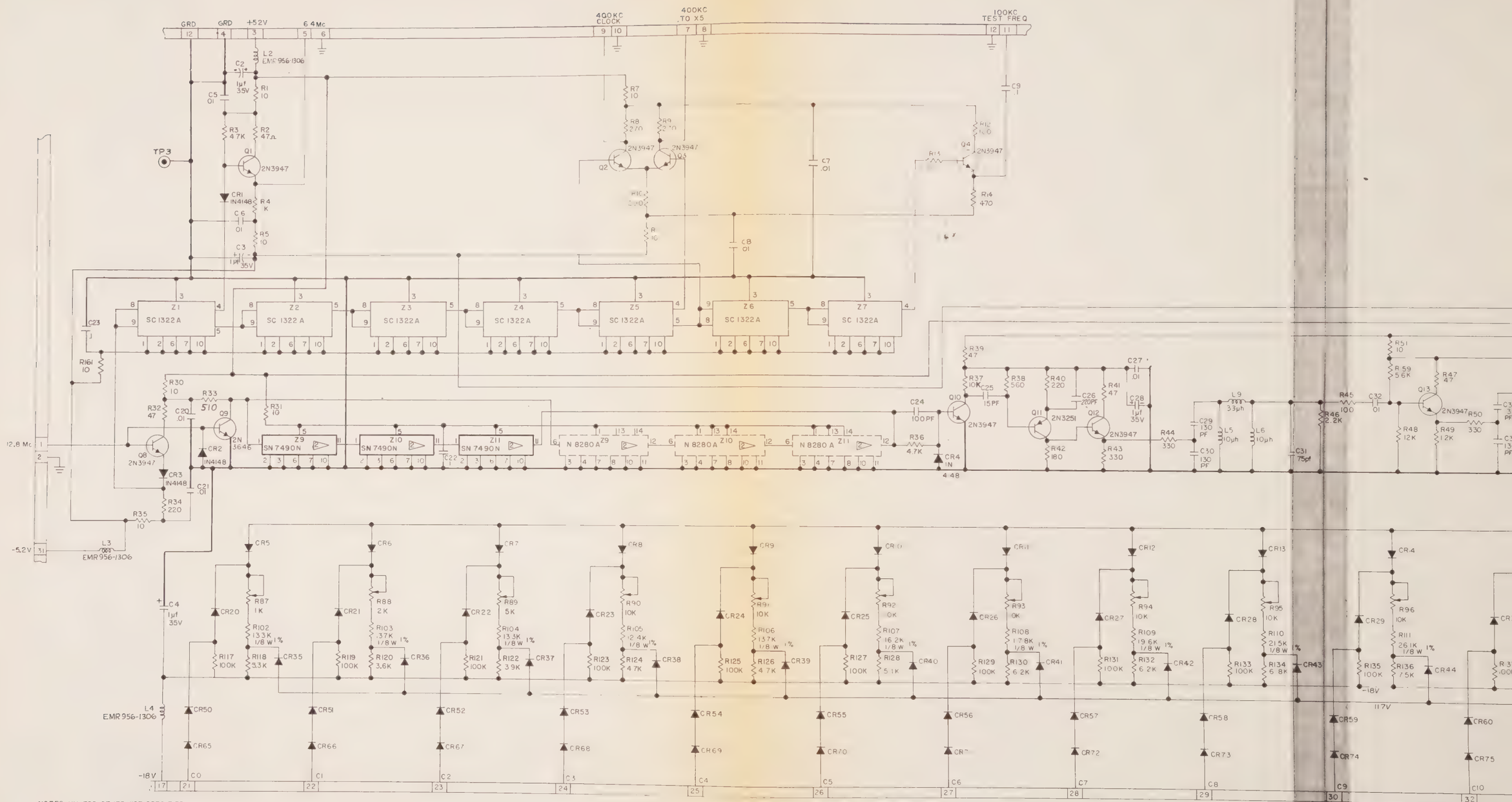
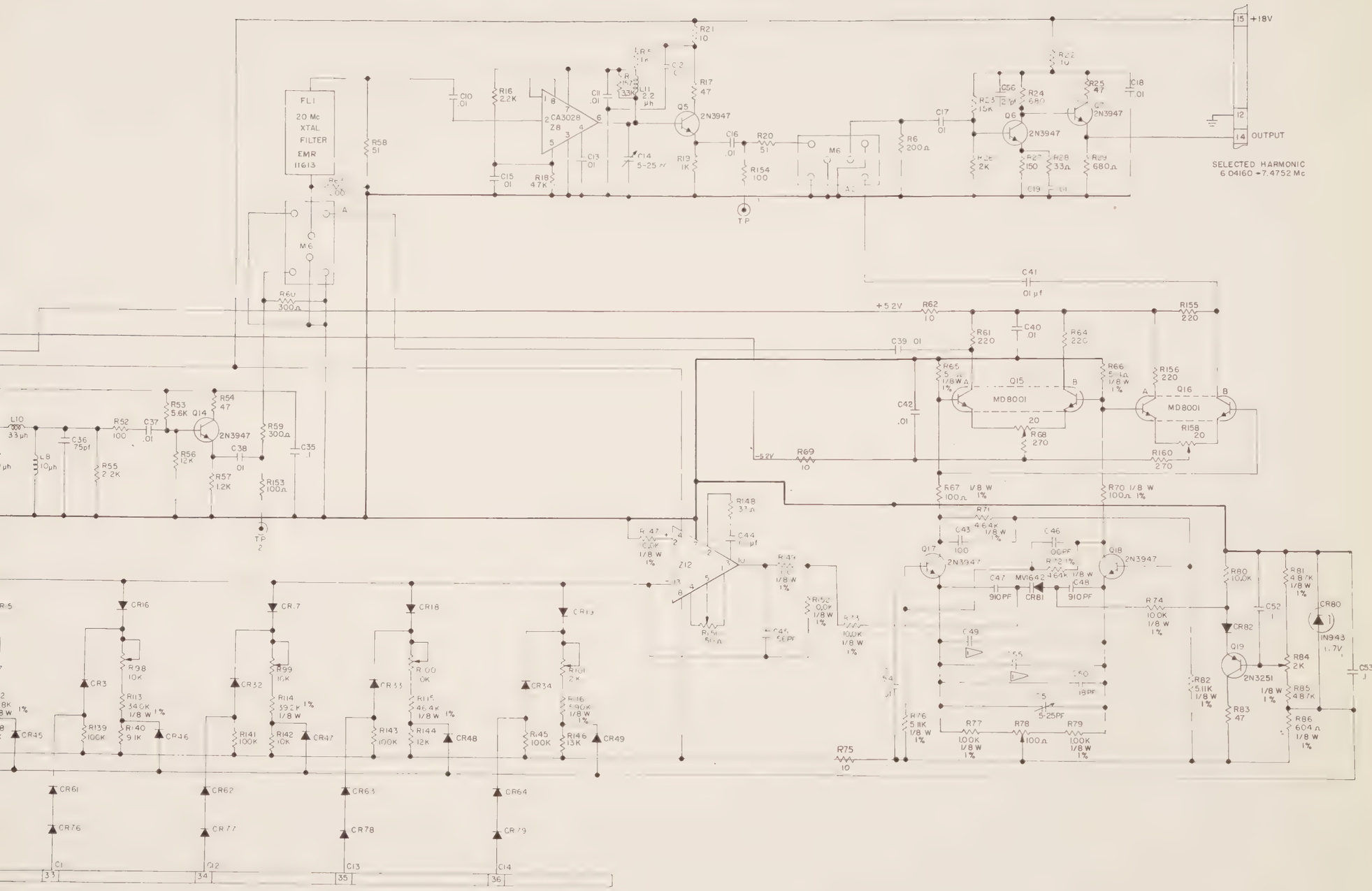


Figure 5-9. Harmonic Selector Card A2A5 Location of Components



NOTES UNLESS OTHERWISE SPECIFIED

1. C49 AND C55 ARE TEMPERATURE COMPENSATING CAPACITORS. ONE OR BOTH MAY BE USED. THEY MAY BE ANY 708-0000-1 BUT WILL PROBABLY BE ONE OF THE FOLLOWING. 708-0147-1, 6.8pf N900 ; 708-0148-1, 6.8pf N1400 ; 708-0149-1, 6.8pf N2200 ; 708-0168-1, 10 pf N1400.
2. FOR Z9, Z10 & Z11 USE SN7490N TYPE IN HEAVY OUT LINE, IF NOT AVAIABLE SUBSTITUTE TYPE N 8280 A IN DOTTED OUTLINE ONLY.
3. ALL DIODES IN4148
4. ALL RESISTOR VALUES IN OHMS. (K=1000)
5. ALL CAPACITOR VALUES IN UF
6. EMR DWG. NO. 15168, REV. D


FL1
20 Mc
XTAL
FILTER
EMR
11613
CA3028
Z8
Z12
2N3947
MD8001
MV1642
2N3251
IN943
1.7V
+18V
OUTPUT
SELECTED HARMONIC
6.04160 → 7.4752 Mc
+5.2V
-5.2V
TP
TP 2
M6
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
A11
A12
A13
A14
A15
A16
A17
A18
A19
A20
A21
A22
A23
A24
A25
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A37
A38
A39
A40

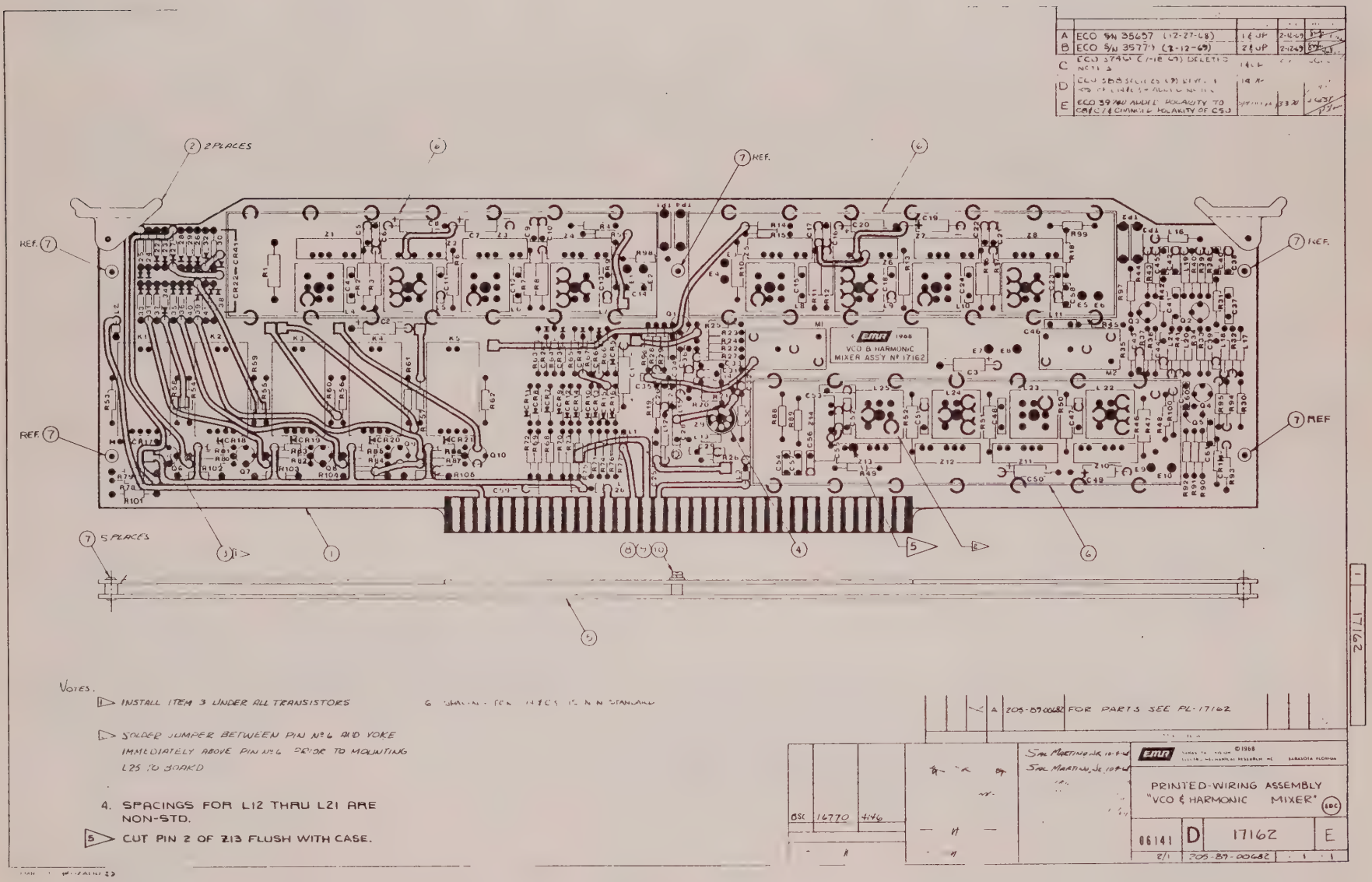


Figure 5-11. VCO and Harmonic Mixer Card A2A6 Location of Components

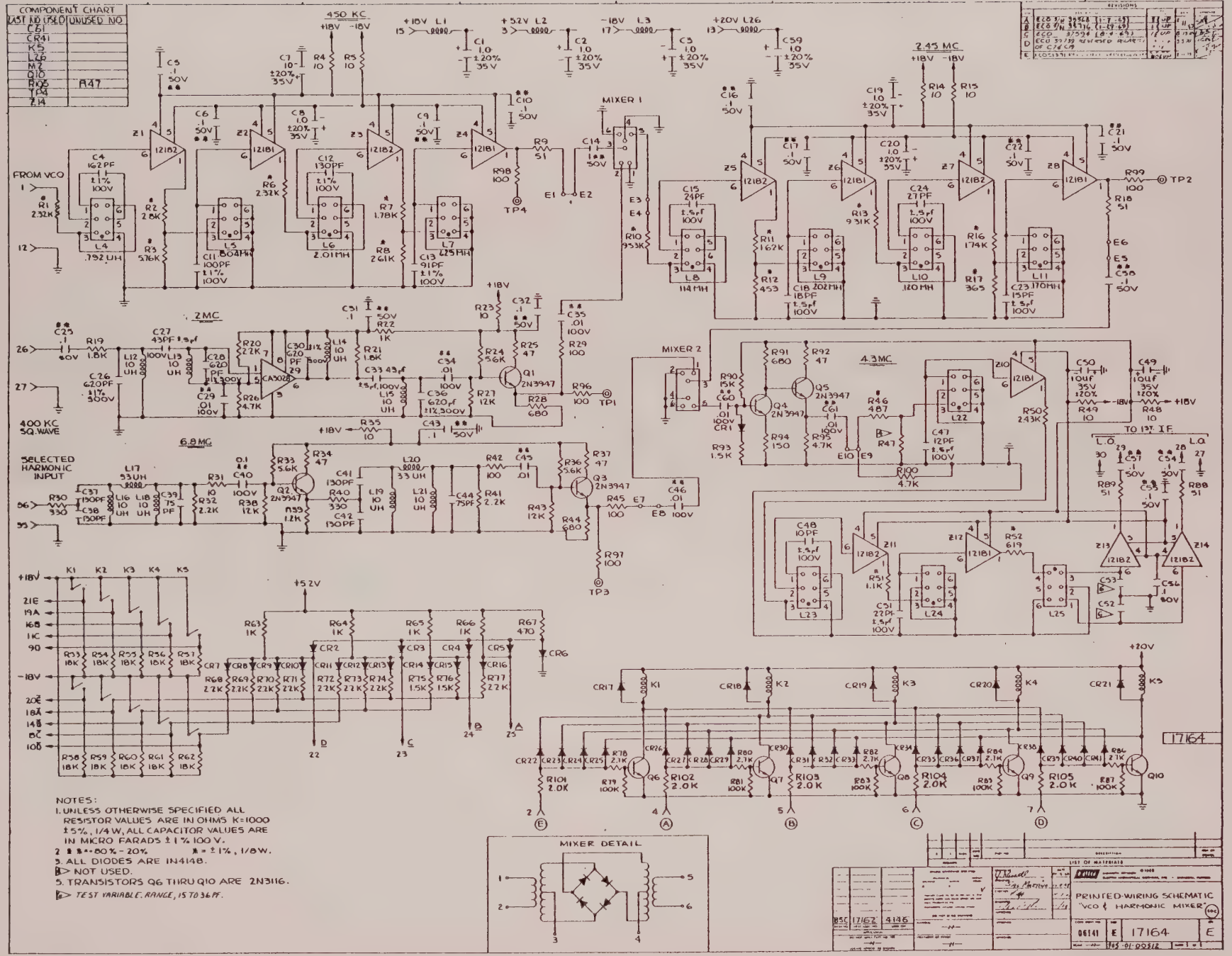


Figure 5-12. VCO and Harmonic Mixer Card A2A6 Schematic Diagram

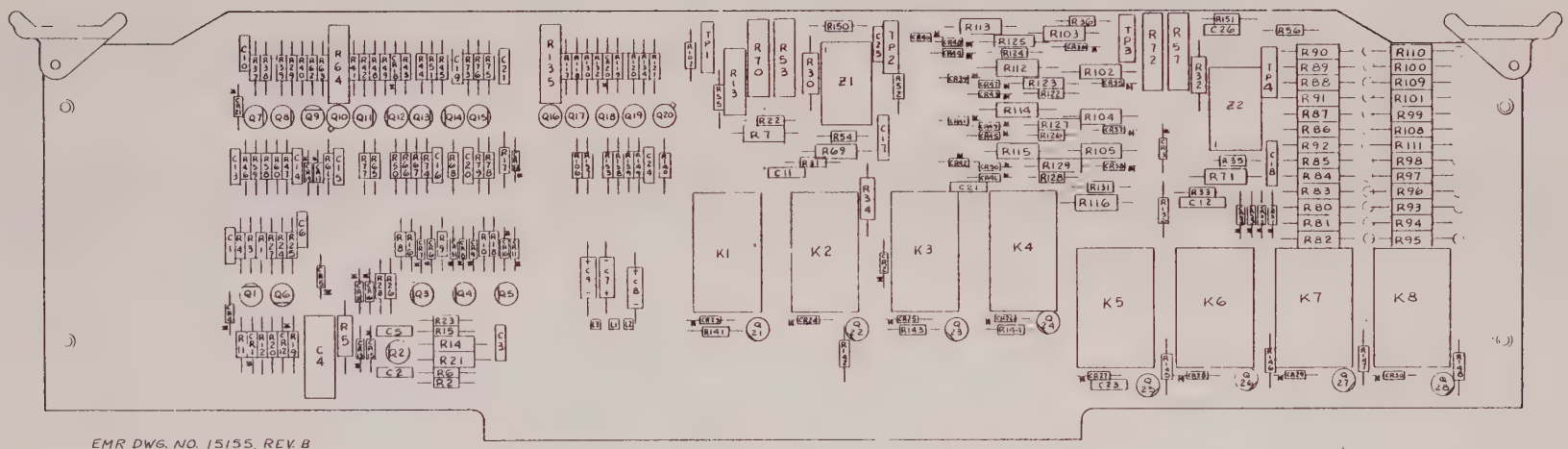


Figure 5-13. Level Adjust and VCO Modulator Card A2A7
Location of Components

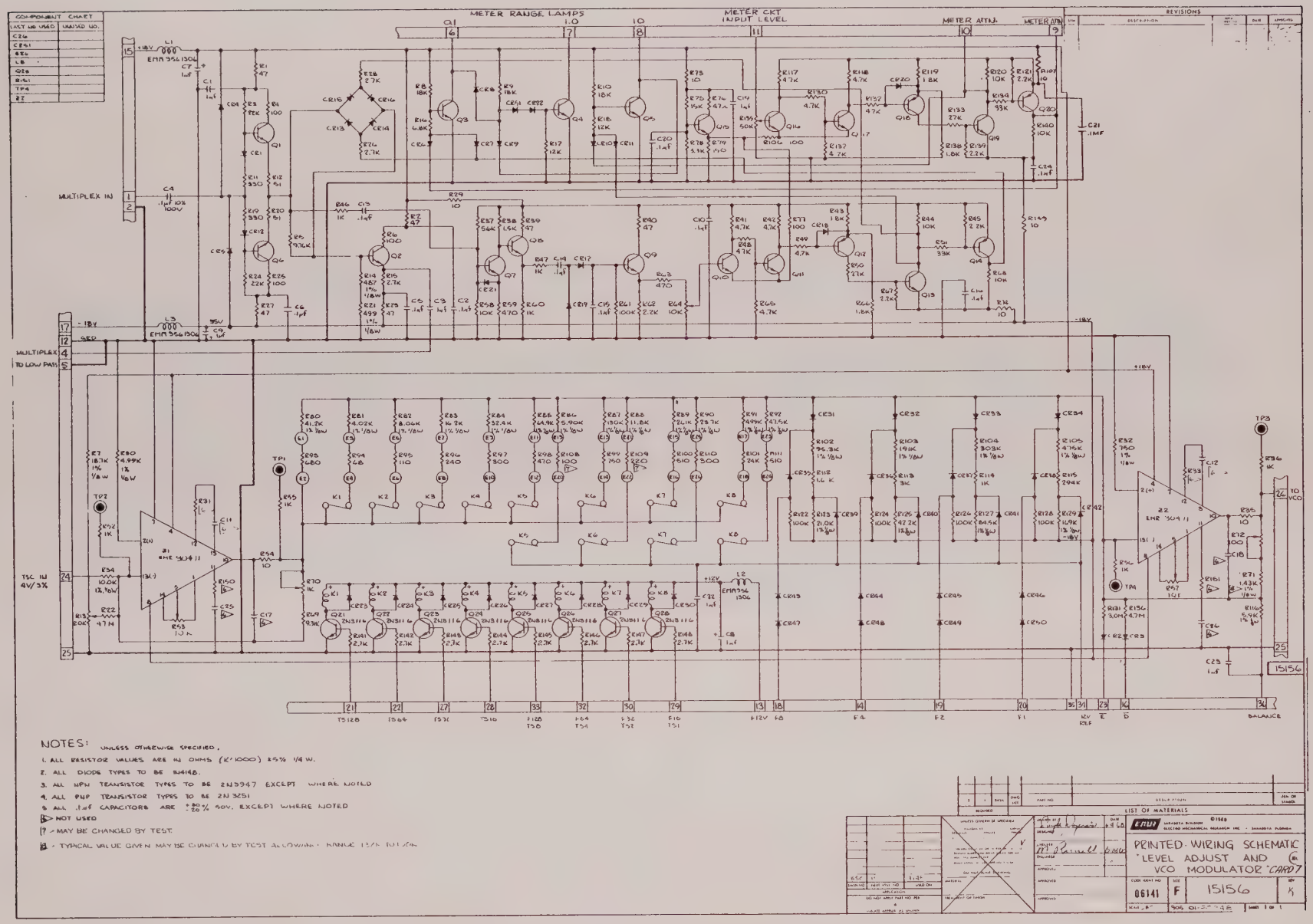


Figure 5-14. Level Adjust and VCO Modulator Card A2A7 Schematic Diagram

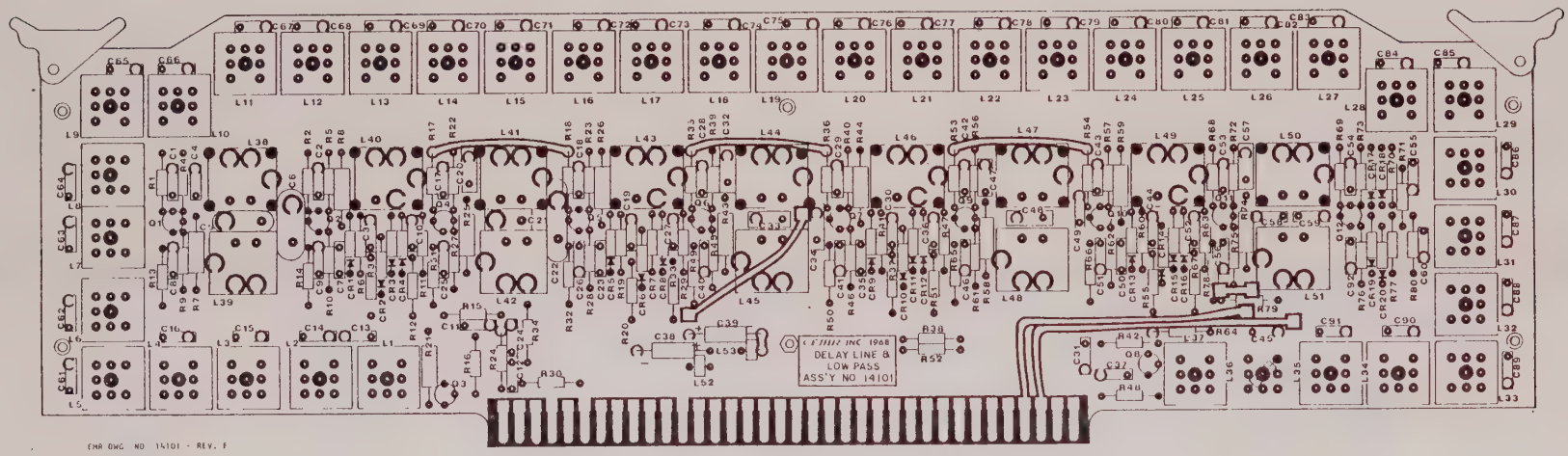


Figure 5-15. Delay Line and Low-Pass Card A2A8 Location of Components

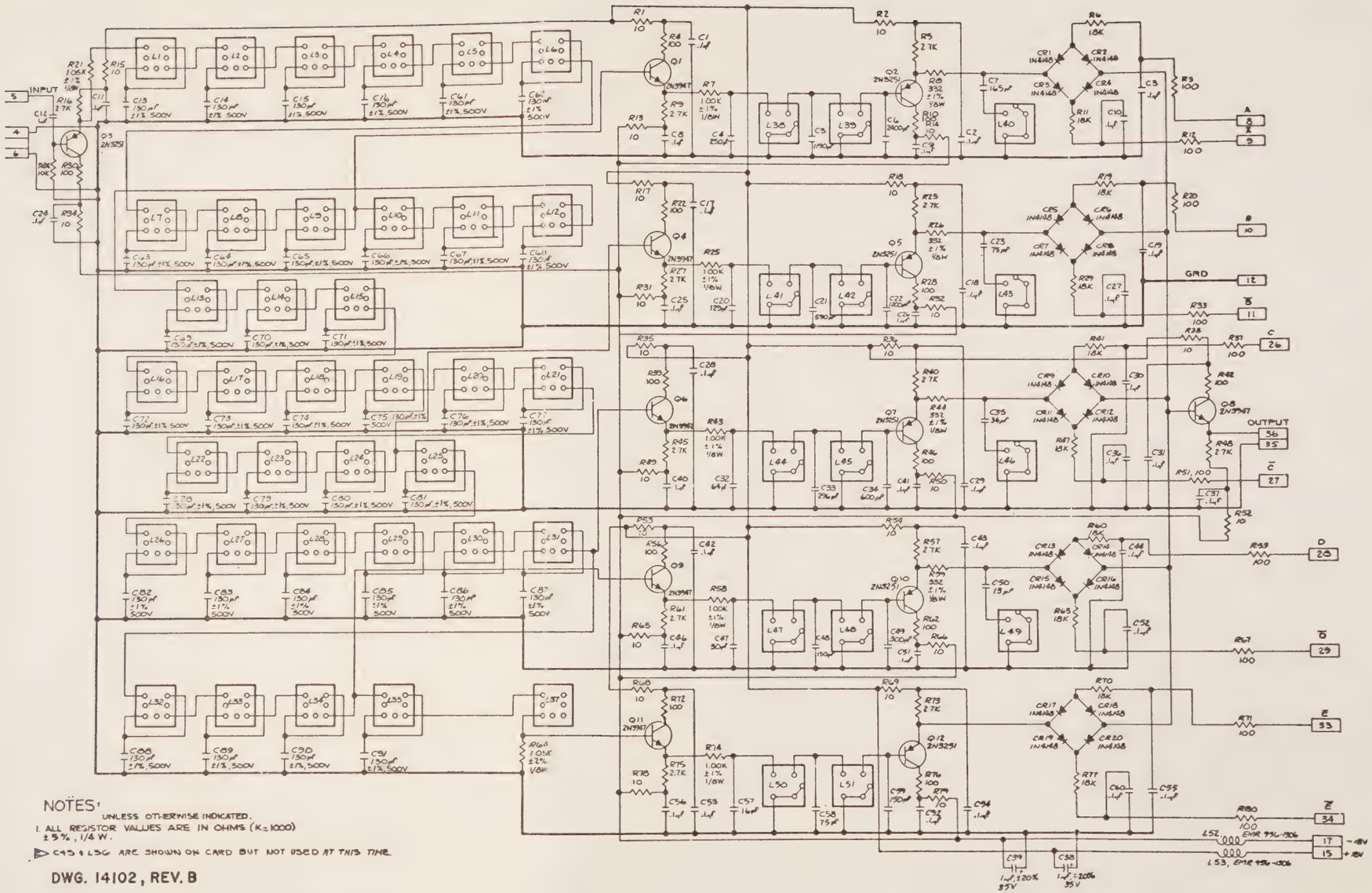


Figure 5-16. Delay Line and Low-Pass Card A2A8 Schematic Diagram

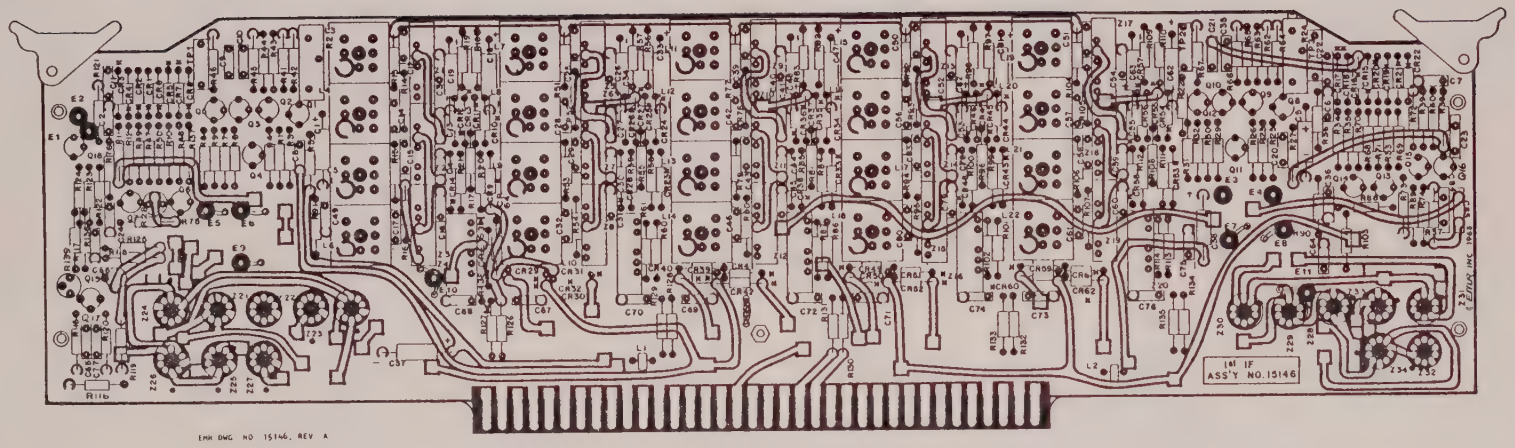
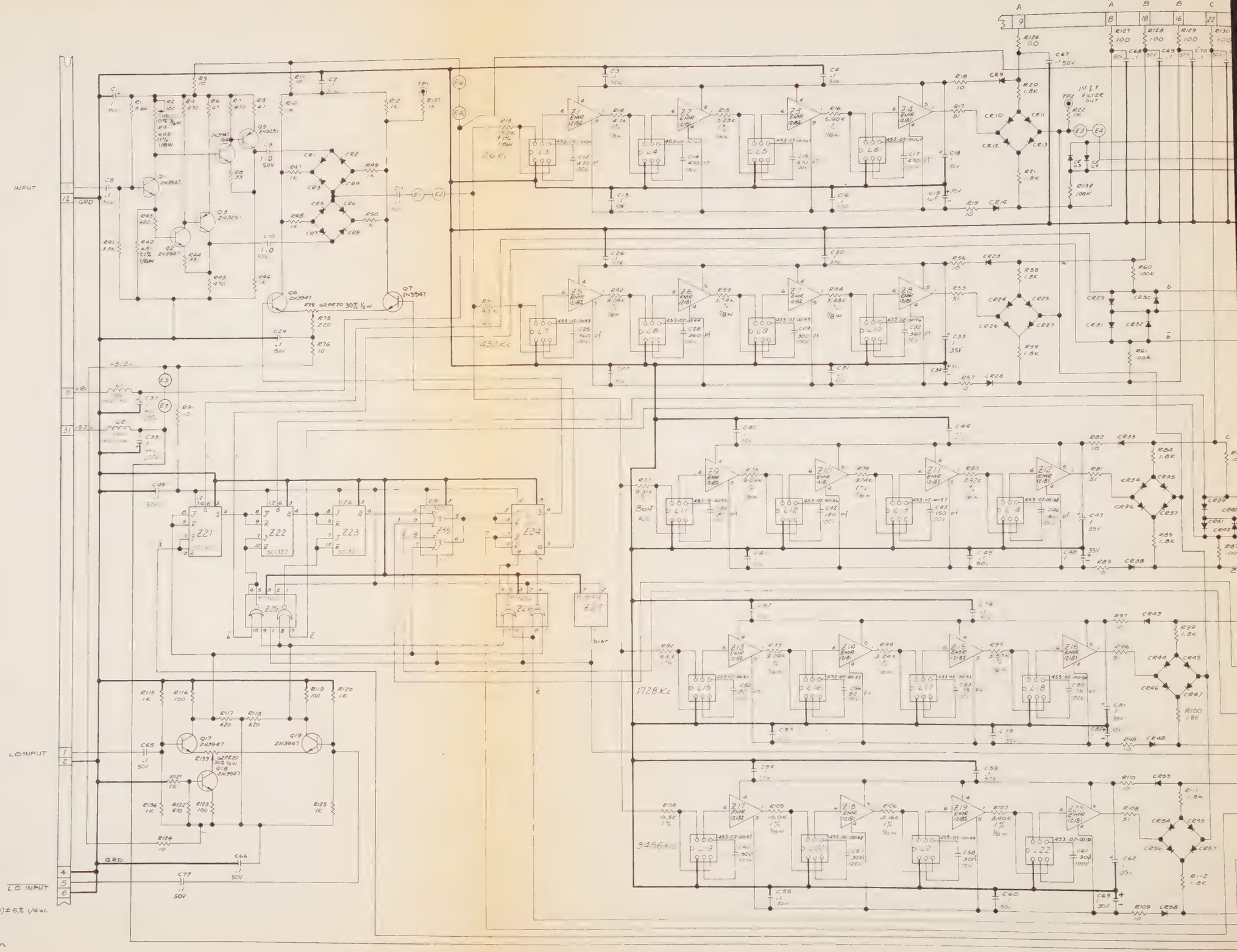


Figure 5-17. First IF Card A2A9 Location of Components



NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTOR VALUES ARE IN OHMS (K=1000) ± 5% 1/4W.
2. ALL DIODES ARE 1N4148
3. ALL CAPACITOR VALUES ARE IN μf.
4. TEST VARIABLE. RANGE; 62 TO 110Ω
5. EMR DWG. 15147, REV. E

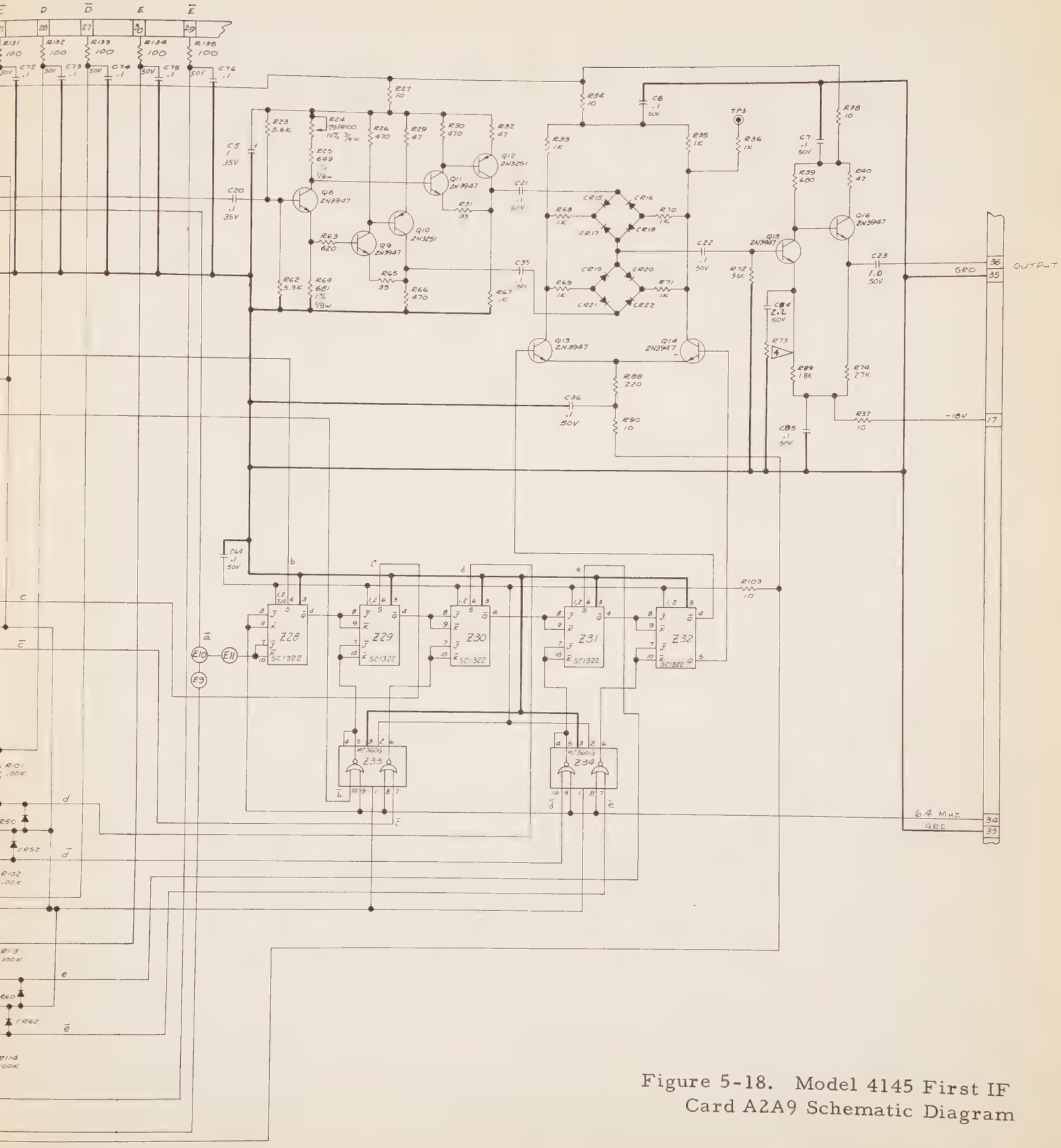


Figure 5-18. Model 4145 First IF Card A2A9 Schematic Diagram

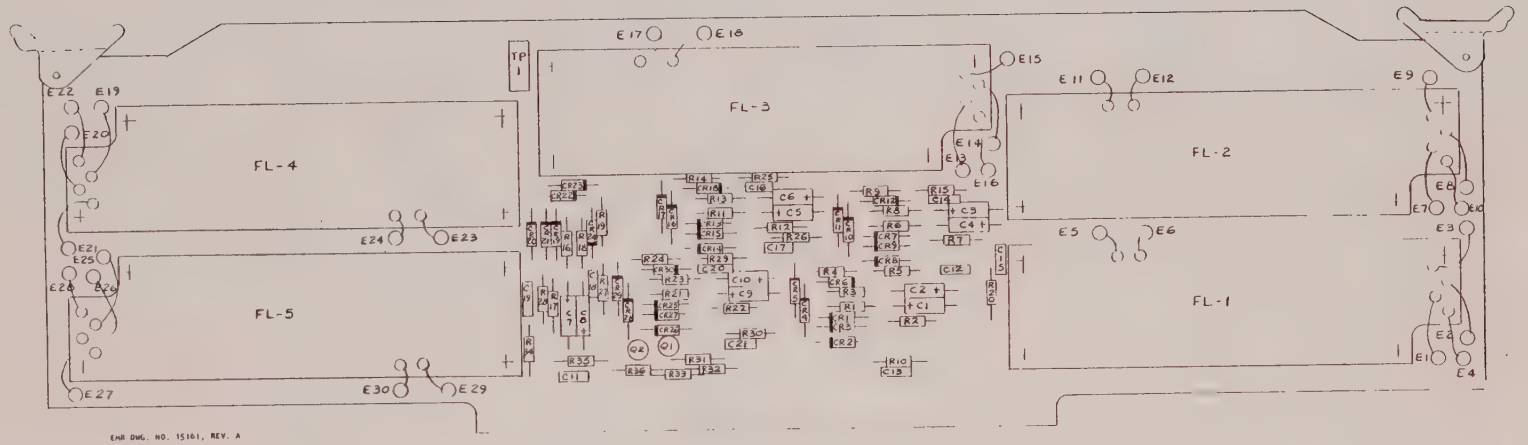
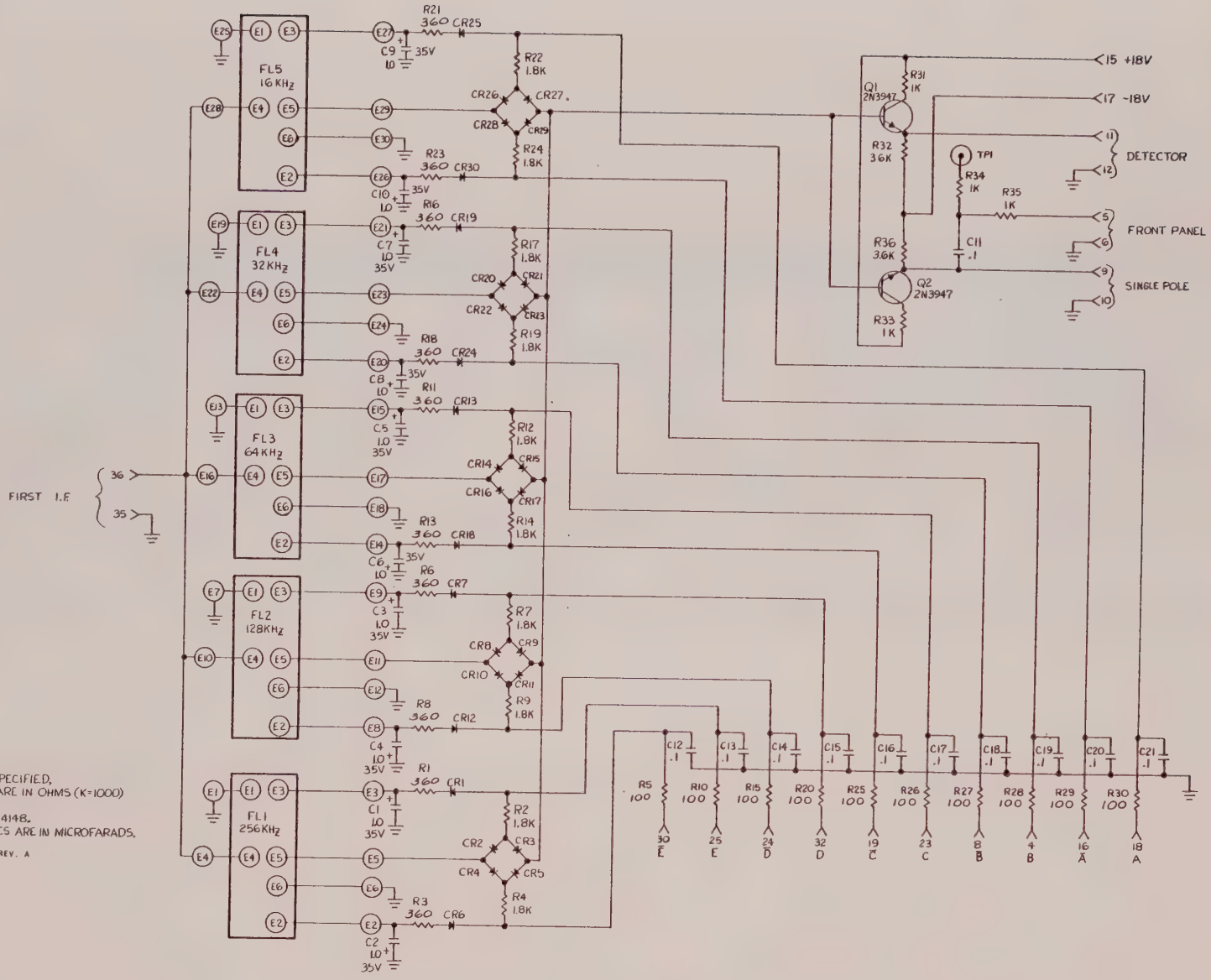


Figure 5-19. Second IF Card A2A10 Location of Components



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS (K=1000) ±5%, 1/4 WATT. ALL DIODES ARE IN4148. ALL CAPACITOR VALUES ARE IN MICROFARADS.
2. EMR DWG. NO. 15162, REV. A

Figure 5-20. Second IF Card A2A10 Schematic Diagram

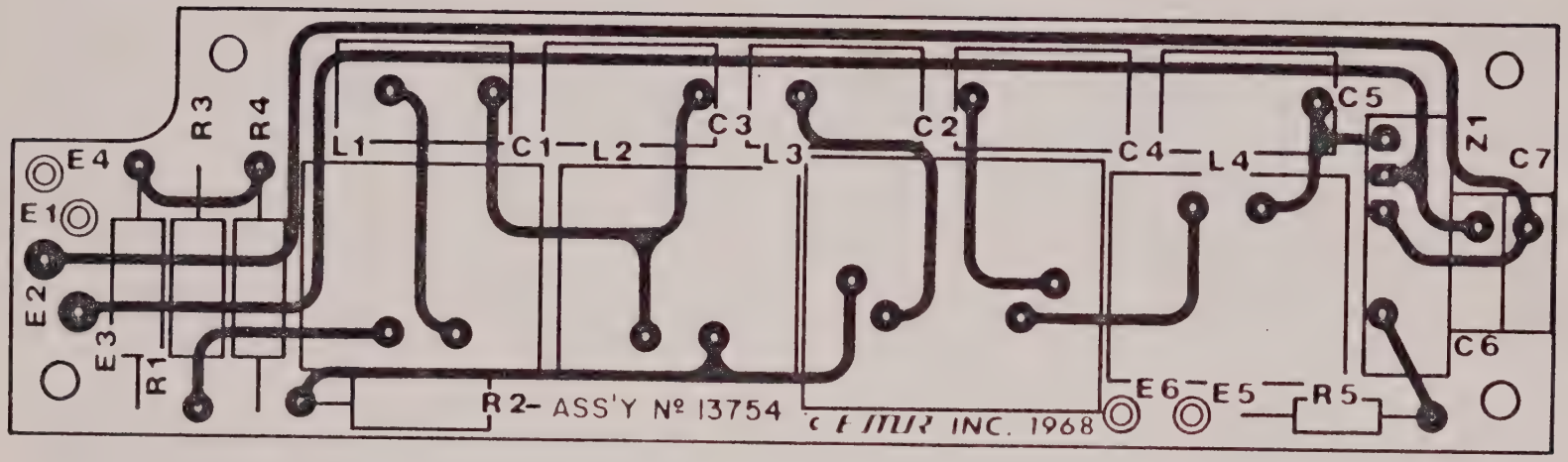
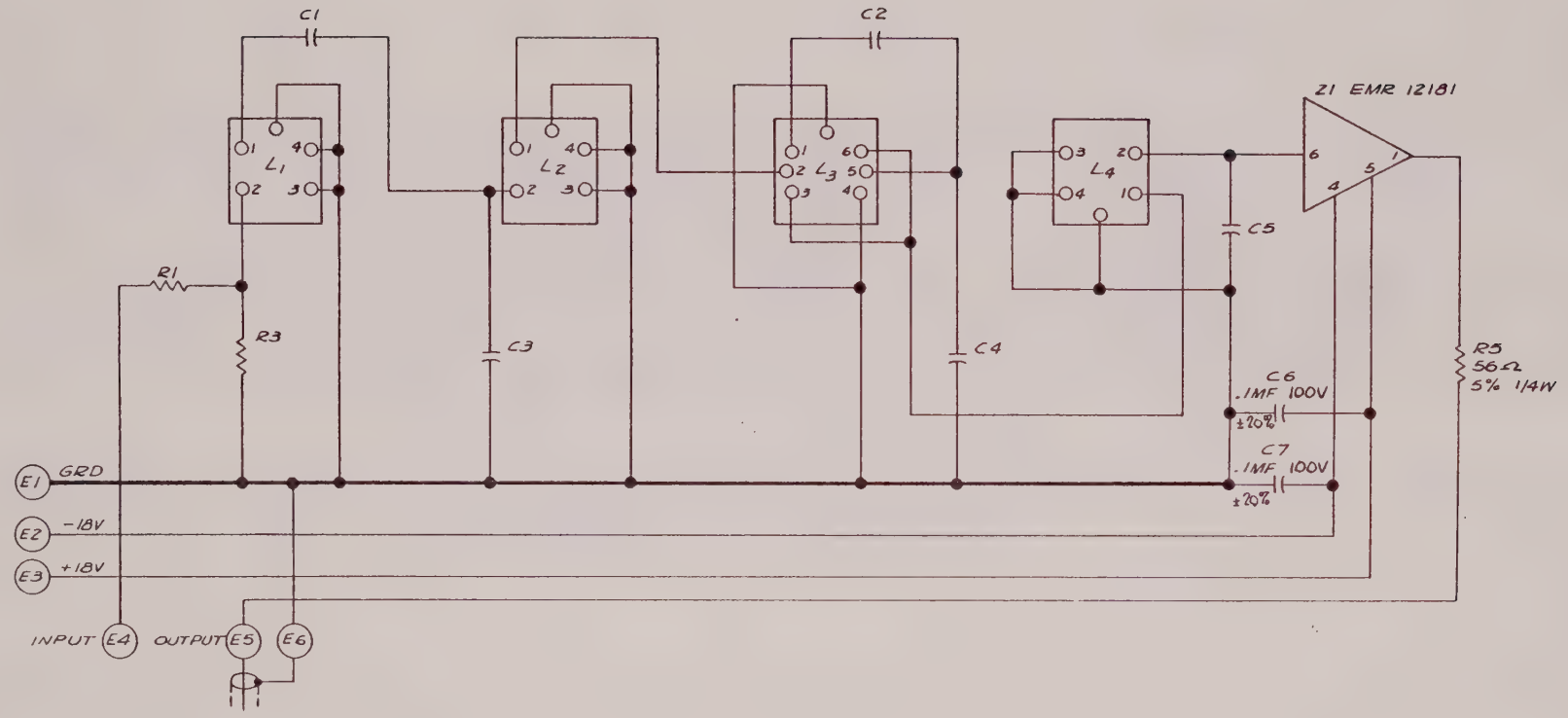


Figure 5-21. Band-Pass Input Filter 4 Pole-Pair Ladder
A2A10FL1 thru A2A10FL5 Location of Components



NOTE:

1. UNLESS OTHERWISE SPECIFIED ALL COMPONENTS ARE FREQ VARIABLES, SEE EMR DRAWING 13771
2. EMR DWG. NO. 13752, REV. ___

Figure 5-22. Band-Pass Input Filter 4 Pole-Pair Ladder A2A10FL1 thru A2A10FL5 Schematic Diagram

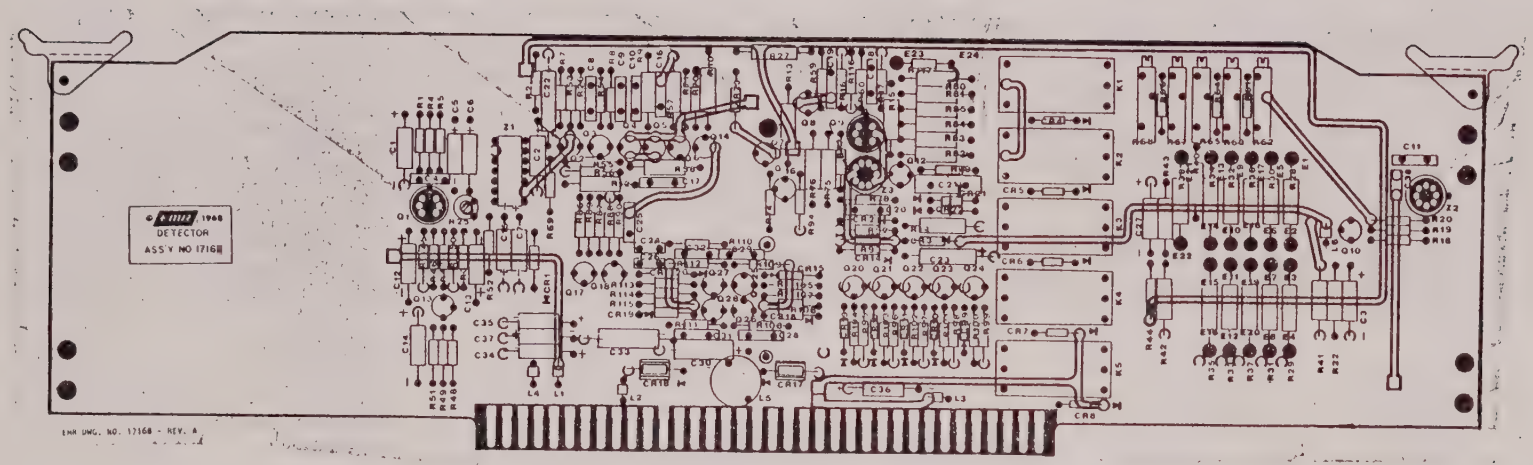


Figure 5-23. Detector Card A2A11 Location of Components

NOTE

The following components shown in Figures 5-23 and 5-24 (the Detector Card) are aged at the factory to provide optimum performance. See paragraph 5.3 before replacing them.

CR17, CR18, CR21, Q6, Q8, Q9, Q12, Q28, Z2, and Z3

NOTES:

1- ALL NPN TRANSISTORS ARE 2N3947 UNLESS OTHERWISE NOTED.
2- ALL PNP TRANSISTORS ARE 2N3251 UNLESS OTHERWISE NOTED.
3- ALL DIODES ARE IN 4148 UNLESS OTHERWISE NOTED

a	BRIDGE BALANCE ADJUST	O - 2.00K	RN60C'S USED
a	T.C. ADJUST BAND A	R36 + R37 ≈ 10K	RN60C'S USED
a	T.C. ADJUST BAND B	R34 + R35 ≈ 10K	RN60C'S USED
a	T.C. ADJUST BAND C	R32 + R33 ≈ 10K	RN60C'S USED
a	T.C. ADJUST BAND D	R30 + R31 ≈ 10K	RN60C'S USED
a	T.C. ADJUST BAND E	R28 + R29 ≈ 10K	RN60C'S USED

10- ALL RESISTOR VALUES ARE IN OHMS (10=1000) ±5%, ¼ WATT UNLESS OTHERWISE NOTED.
11- OVERALL TIMING 0-499 ~ RN60C'S USED
12- ALL TOLERANCES ARE ± UNLESS OTHERWISE NOTED.
13- BAND E TIMING 2.00-2.43K RN60C'S USED

16. EMR DWG. NO. 17170 - REV 9

Figure 5-24. Model 4145 Detector Card A2A11 Schematic Diagram

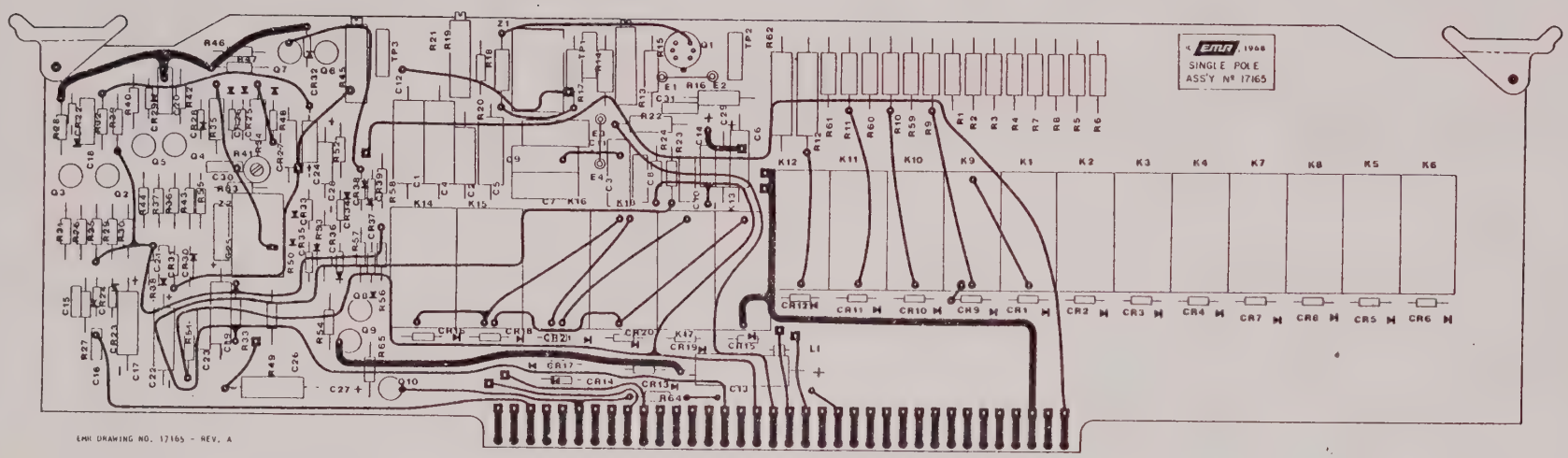


Figure 5-25. Single Pole Filter Card A2A12 Location of Components

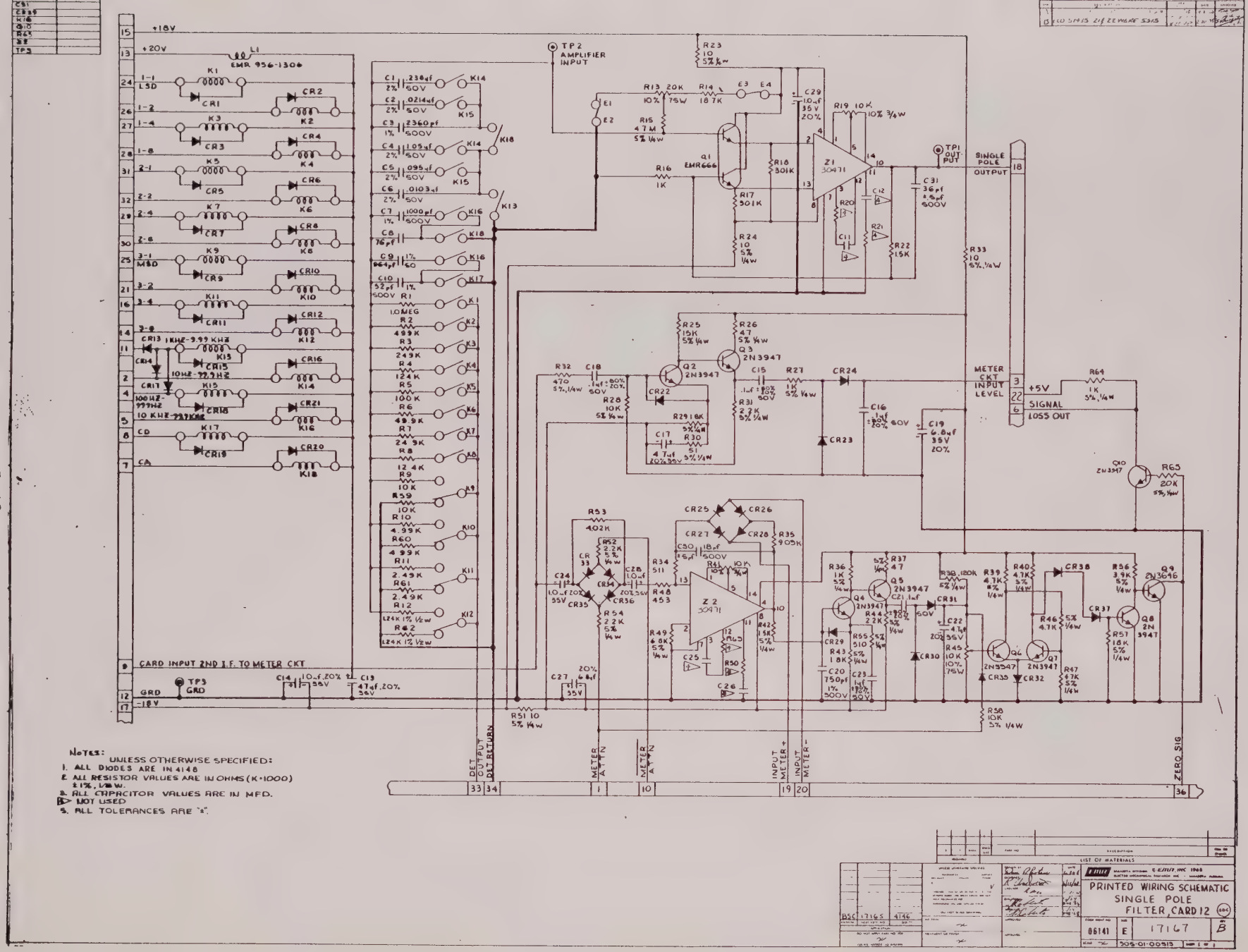


Figure 5-26. Single Pole Filter Card A2A12 Schematic Diagram

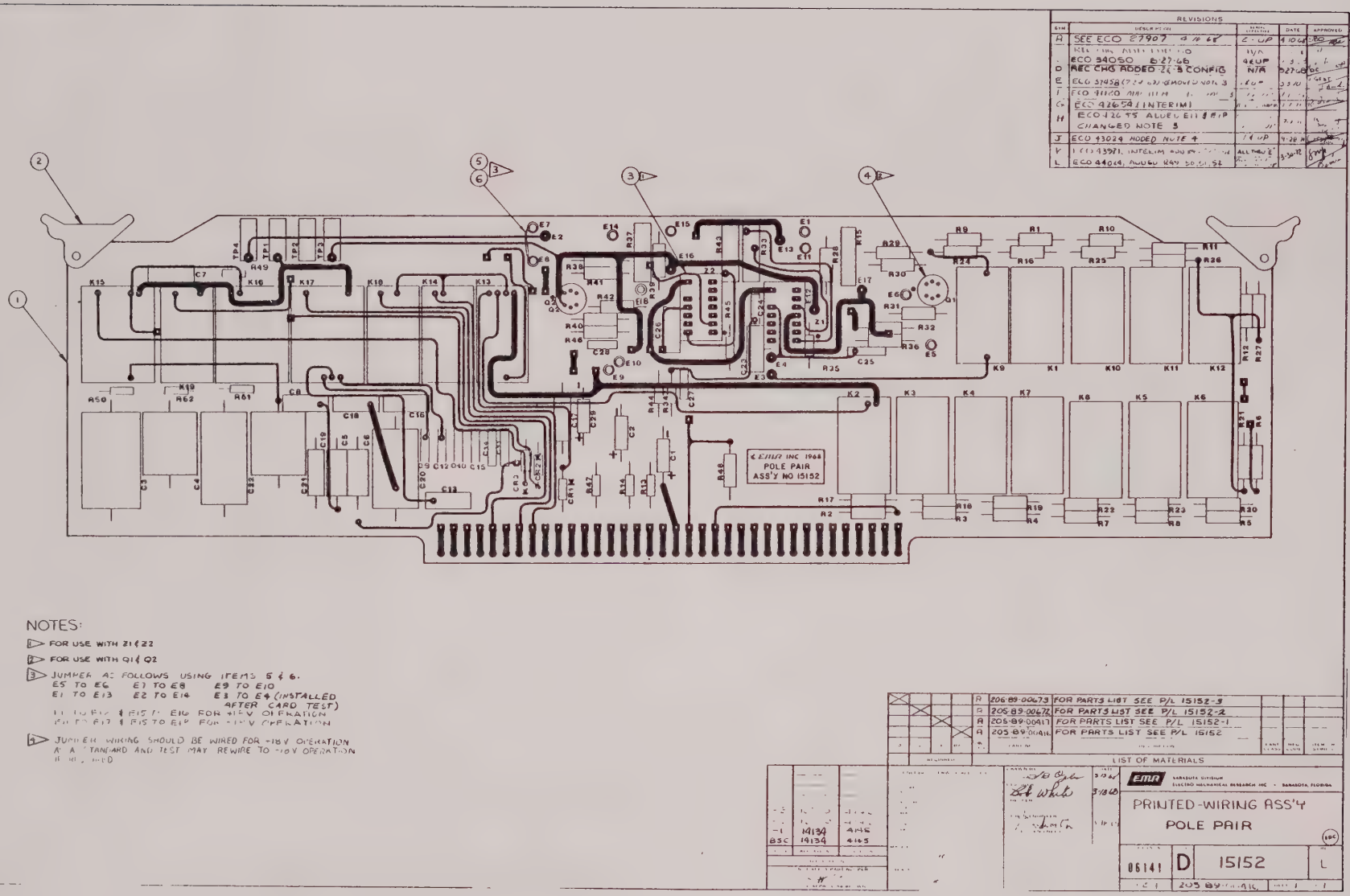
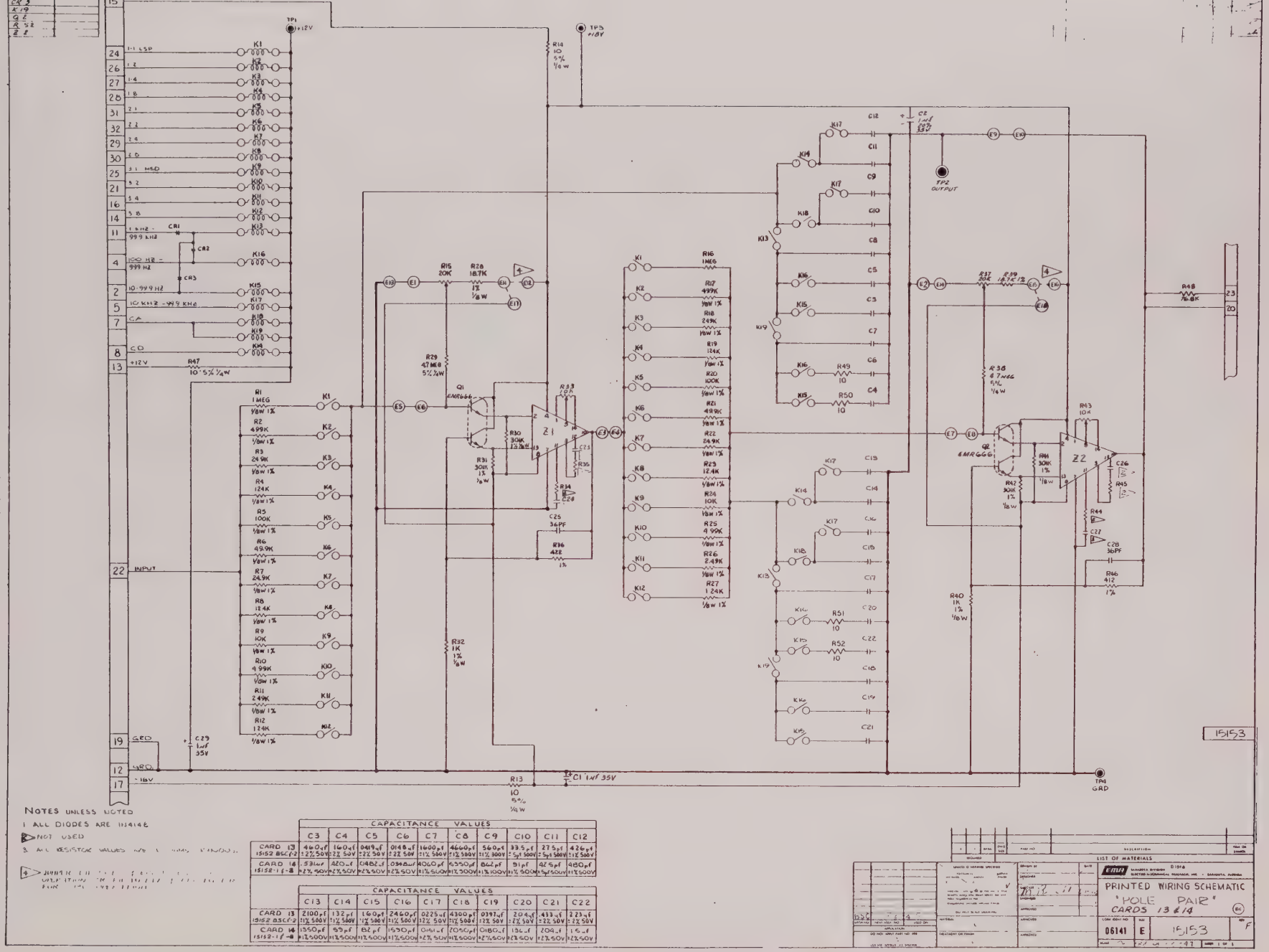


Figure 5-27. Pole Pair Cards A2A13 and A2A14 Location of Components



	CAPACITANCE VALUES									
	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
CARD 13 15152 BSC-2	460 pf ±2% 50V	160 pf ±2% 50V	0419 pf ±2% 50V	0148 pf ±2% 50V	1600 pf ±1% 500V	4660 pf ±1% 500V	560 pf ±1% 300V	33.5 pf ±5% 500V	27.5 pf ±5% 500V	426 pf ±1% 500V
CARD 14 15152-1 & -2	.531 µf ±2% 50V	420 pf ±2% 50V	0482 pf ±2% 50V	.0348 µf ±2% 50V	4060 pf ±1% 500V	6550 pf ±1% 500V	862 pf ±1% 100V	51 pf ±1% 500V	42.5 pf ±5% 500V	480 pf ±1% 500V

	CAPACITANCE VALUES									
	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22
CARD 13 15152 BSC-2	2100 pf ±1% 500V	132 pf ±1% 500V	160 pf ±1% 500V	2460 pf ±1% 500V	0225 pf ±2% 50V	4300 pf ±1% 500V	0397 pf ±2% 50V	204 pf ±2% 50V	.433 µf ±2% 50V	223 pf ±2% 50V
CARD 14 15152-1 & -2	1350 pf ±1% 500V	59 pf ±1% 500V	82 pf ±1% 500V	1590 pf ±1% 500V	0151 pf ±2% 50V	2050 pf ±1% 500V	0180 pf ±2% 50V	136 pf ±2% 50V	204 pf ±2% 50V	15 pf ±2% 50V

Figure 5-28. Pole Pair Cards A2A13 and A2A14 Schematic Diagram

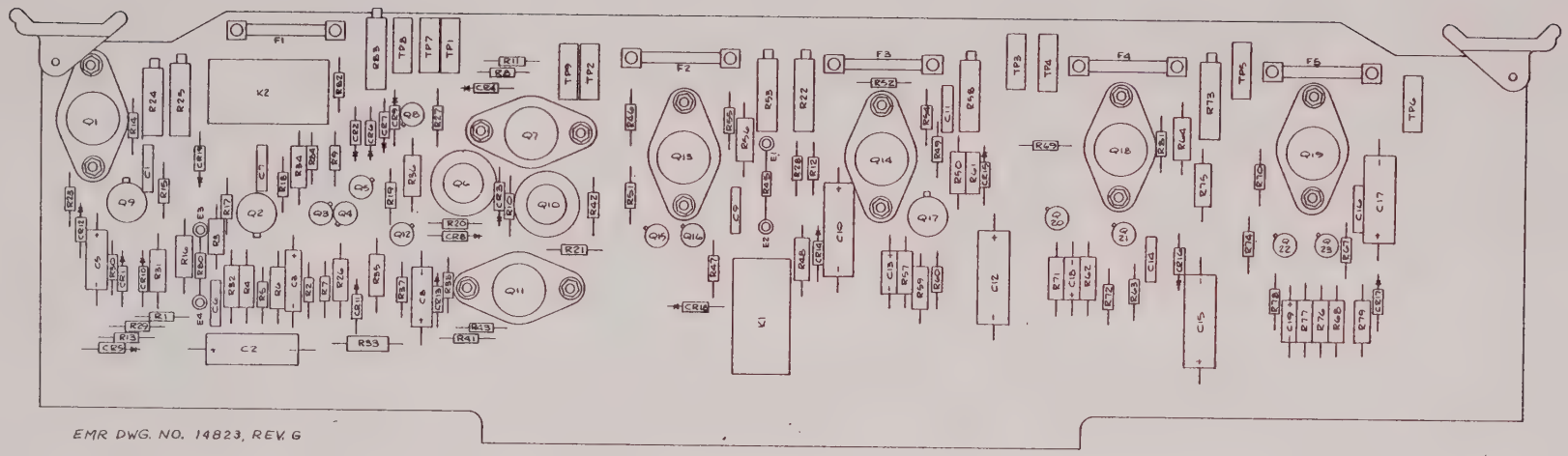


Figure 5-29. Regulator/Output Amplifier Card A2A15
Location of Components

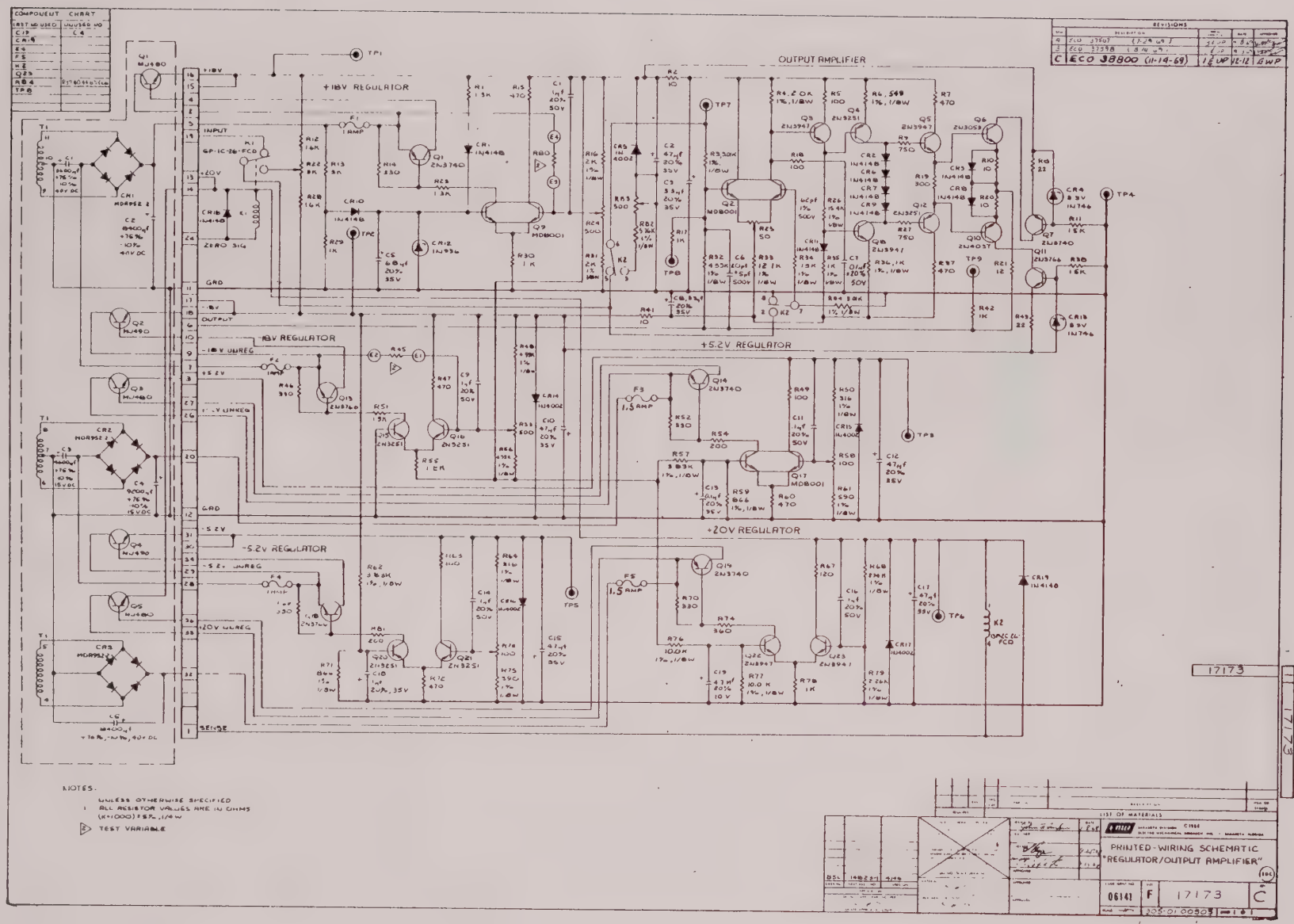


Figure 5-30. Regulator/Output Amplifier Card A2A15 Schematic Diagram

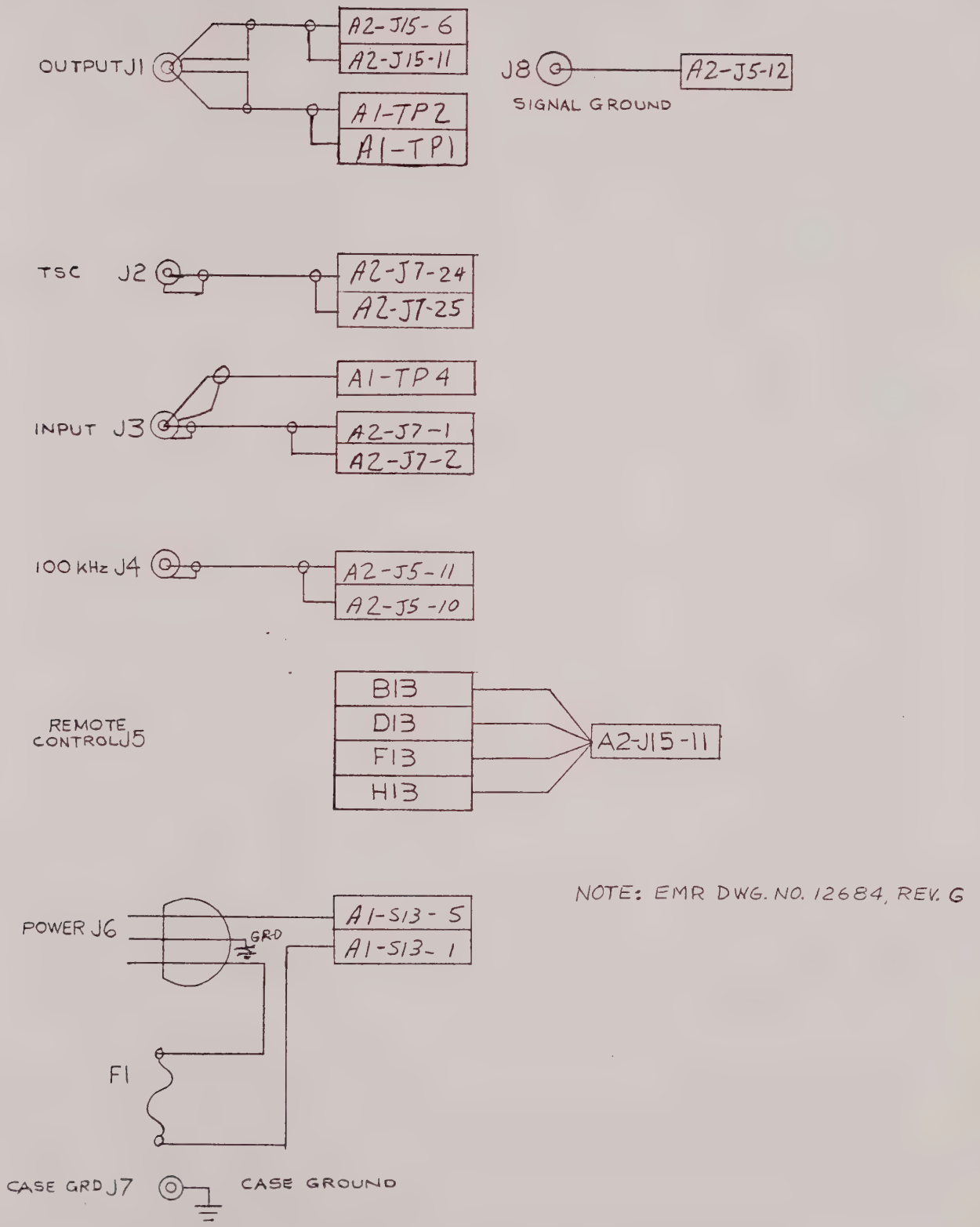


Figure 5-31. Rear Connector Panel A3 Wiring Diagram

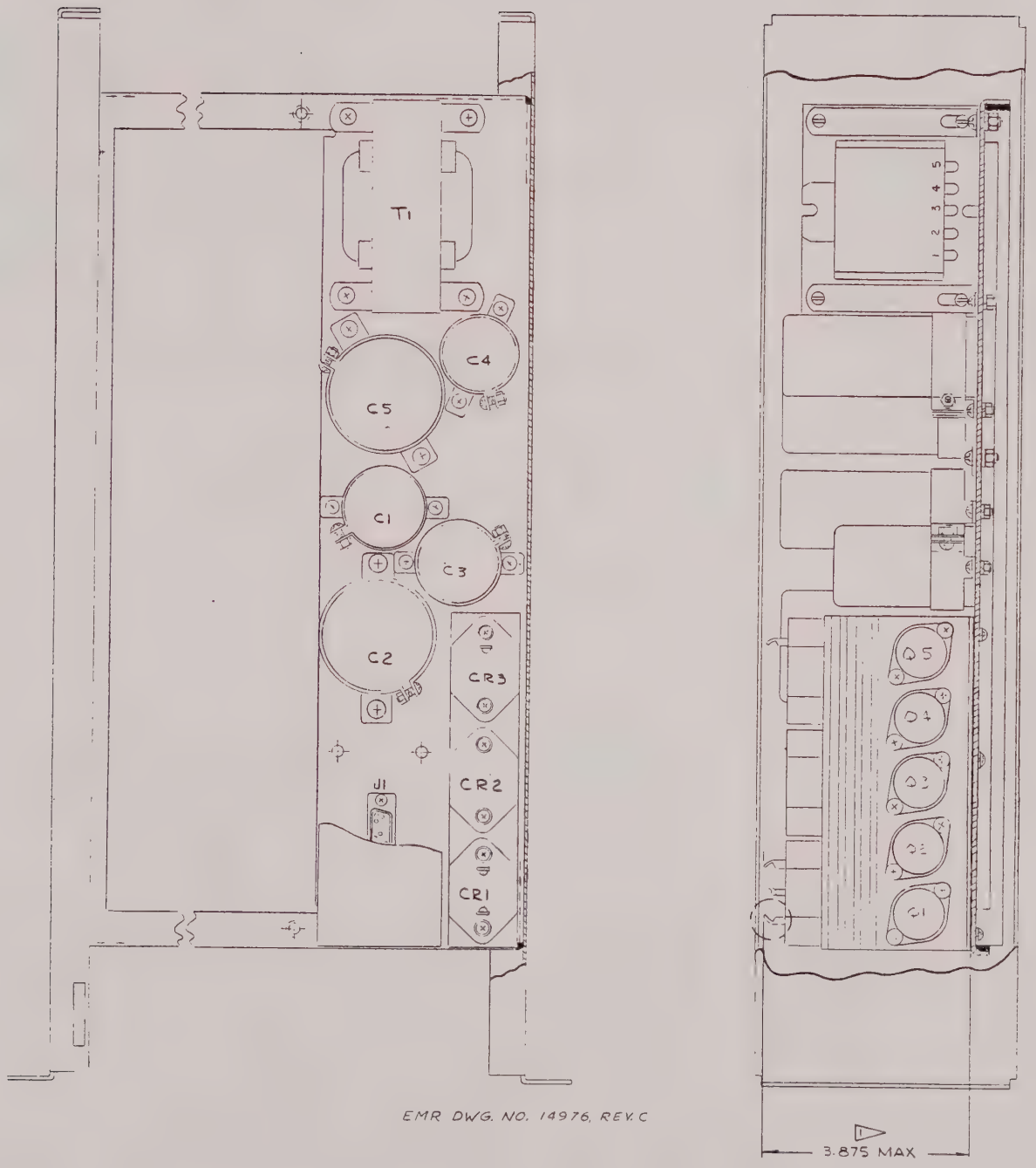


Figure 5-32. Power Supply Assembly A4
Location of Components

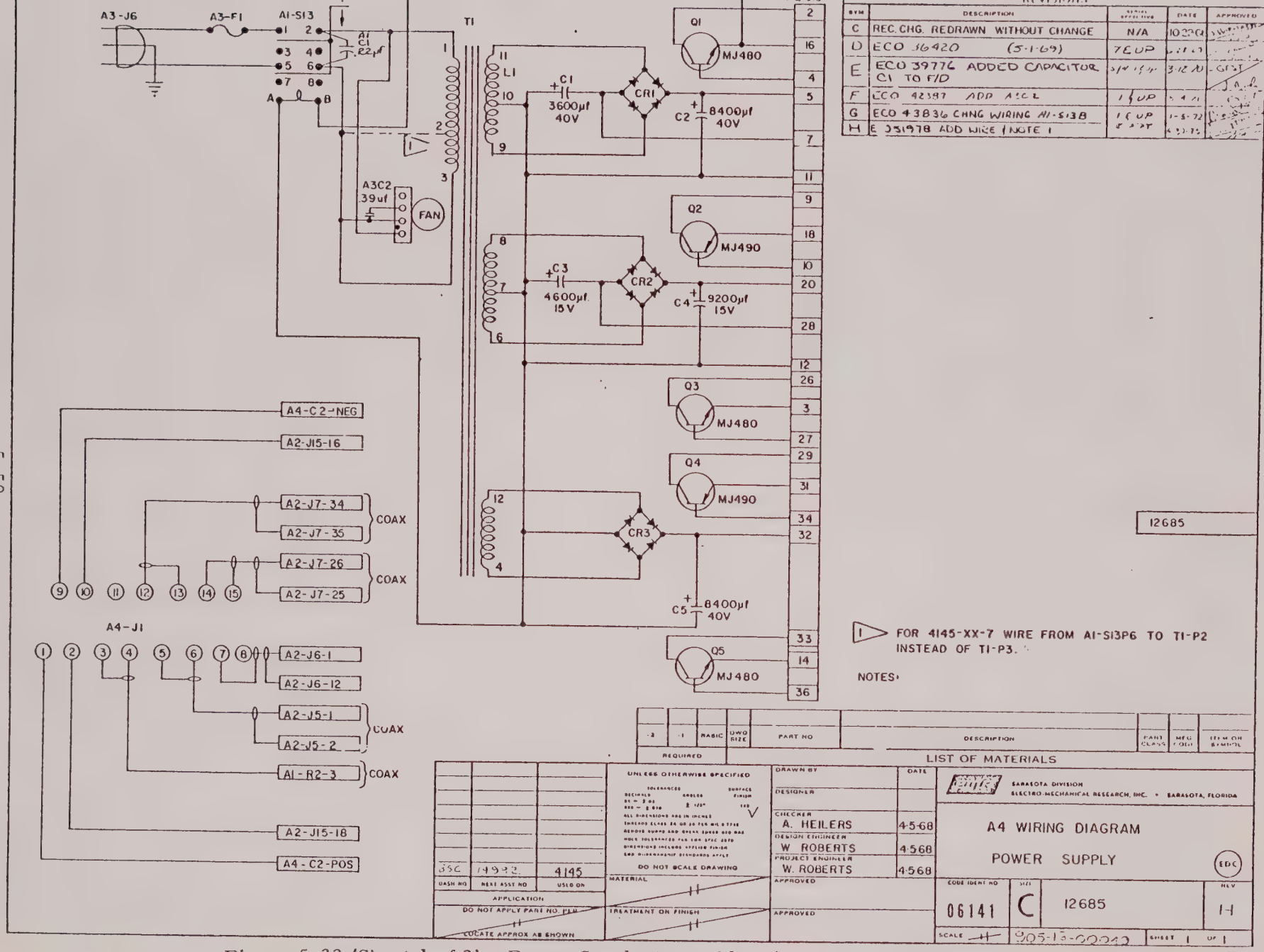


Figure 5-33 (Sheet 1 of 2). Power Supply Assembly A4 Schematic Diagram (Model 4145-01-0)

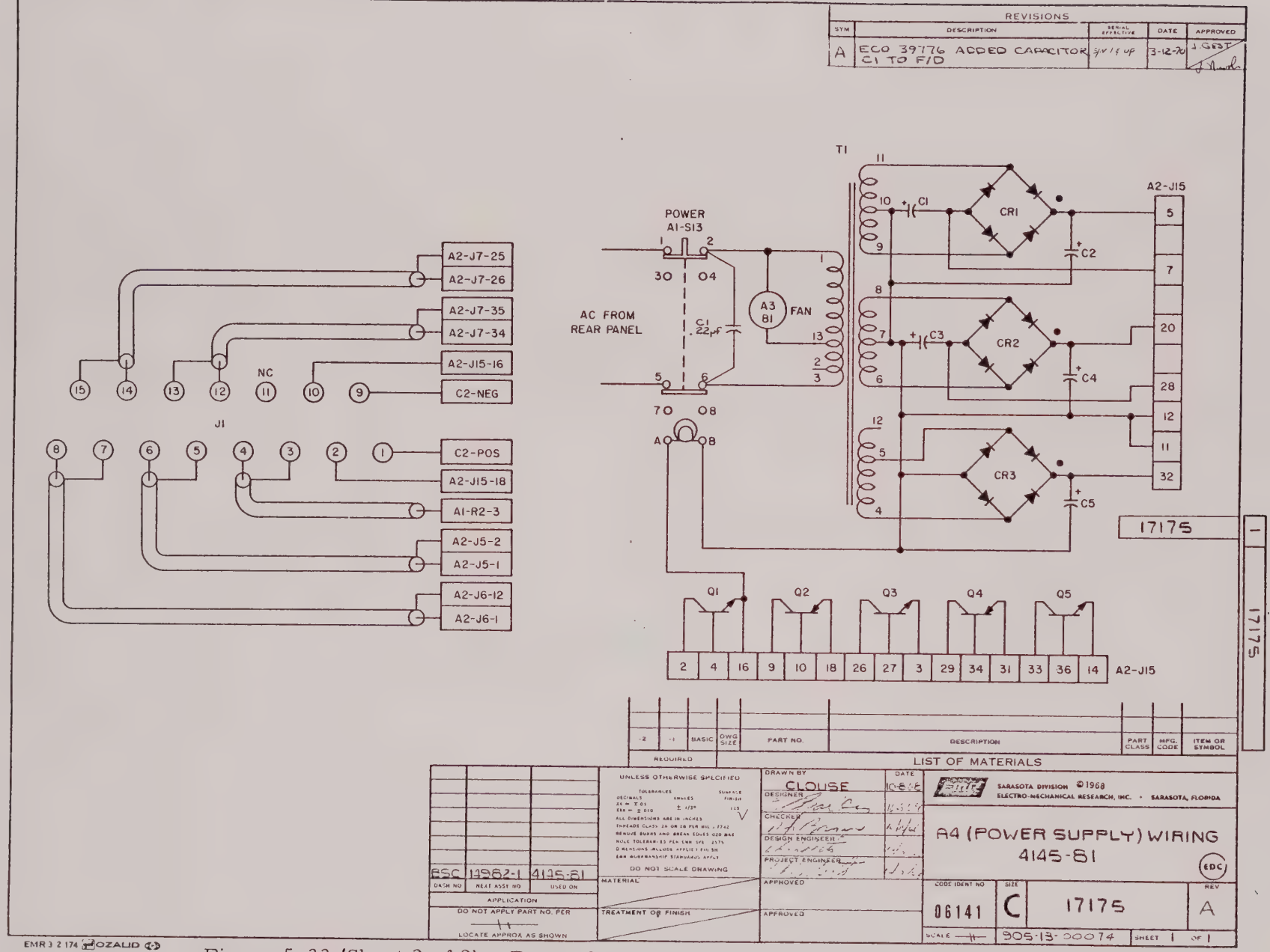
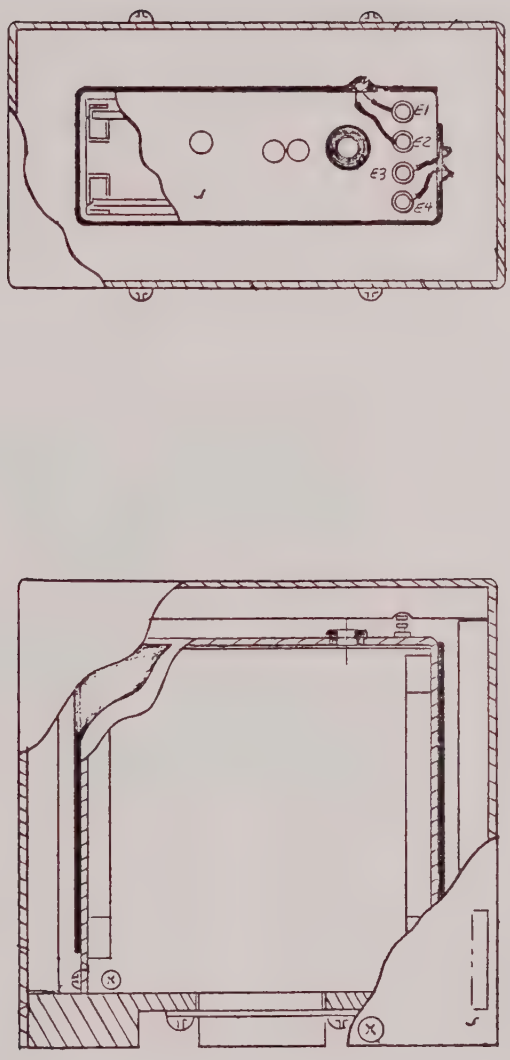


Figure 5-33 (Sheet 2 of 2). Power Supply Assembly A4 Schematic Diagram (Model 4145-01-8)



EMR DWG. NO. 14981, REV. C

Figure 5-34. Oven Assembly A4A1
Location of Components

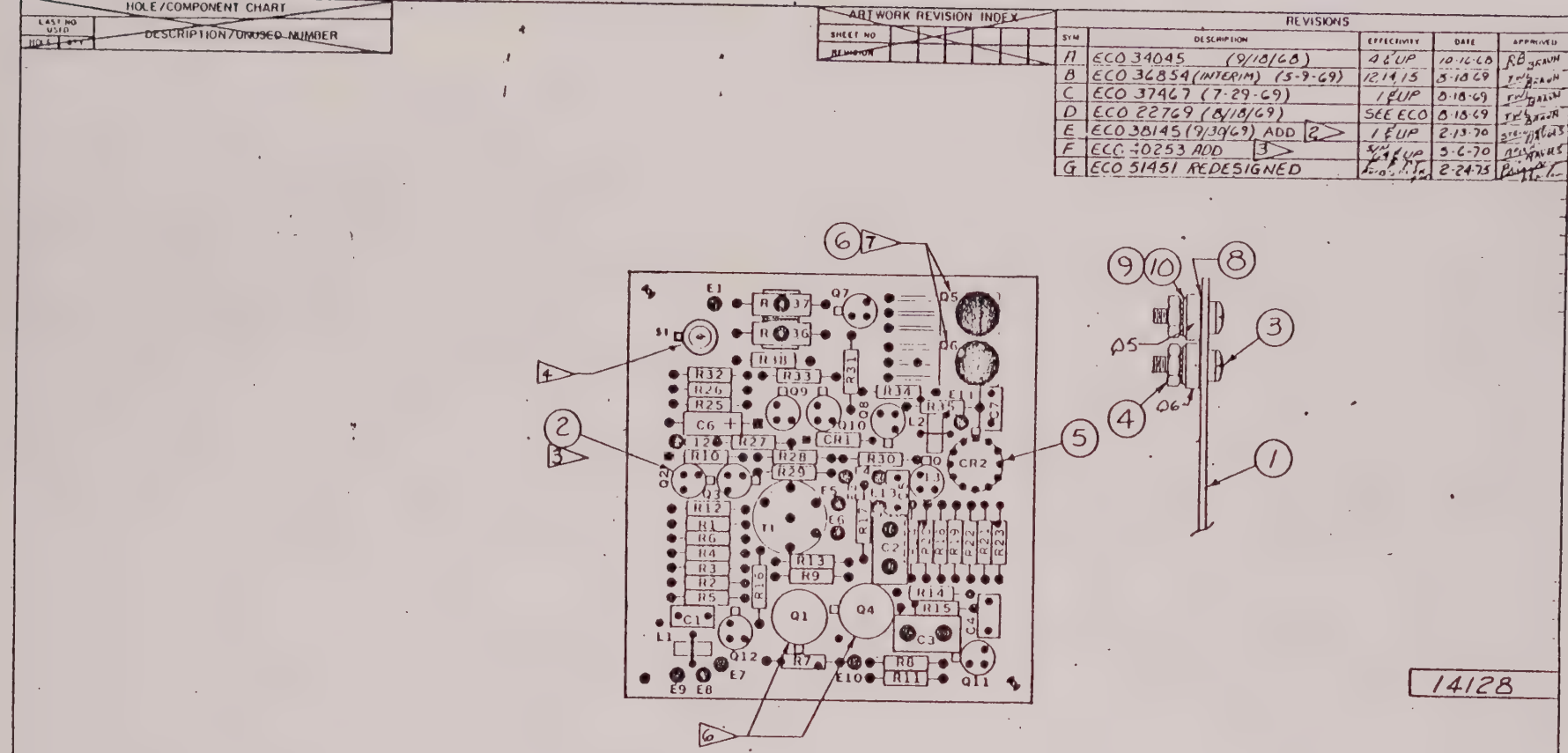
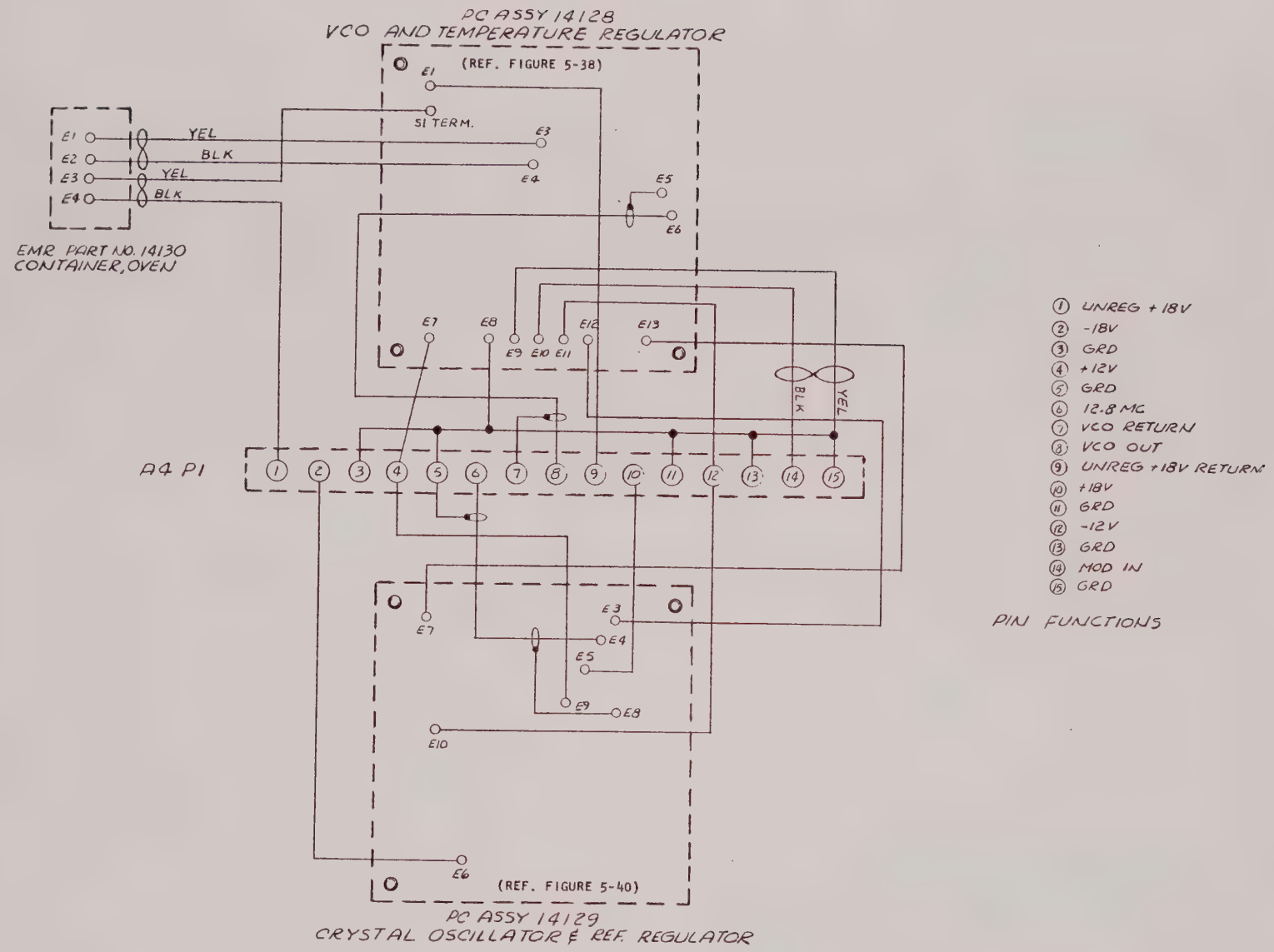


Figure 5-36. VCO and Temperature Regulator Card A4A1A1 Location of Components



NOTE: EMR DWG. NO. 14985, REV. A

Figure 5-35. Oven Assembly A4A1 Wiring Diagram

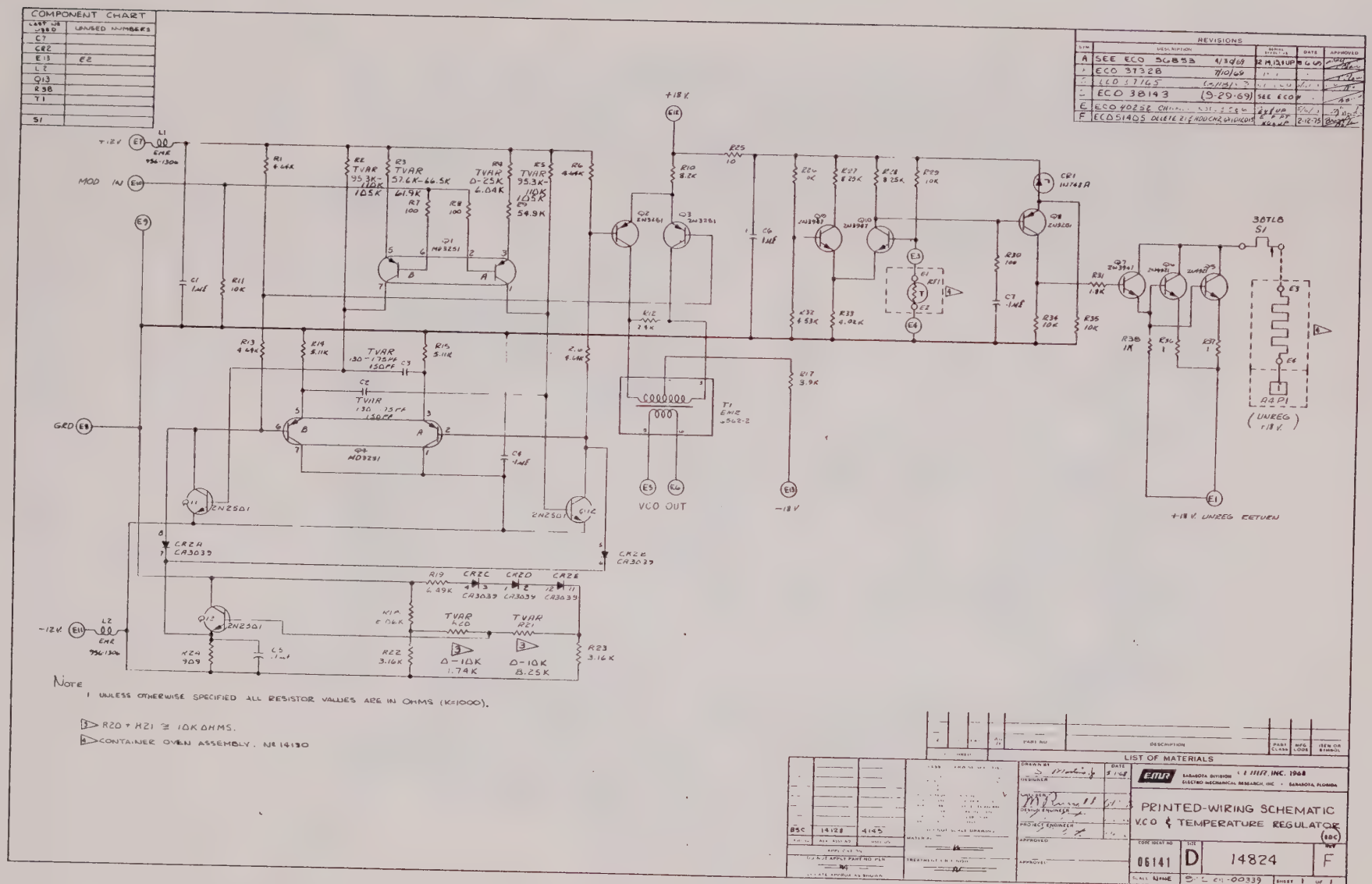
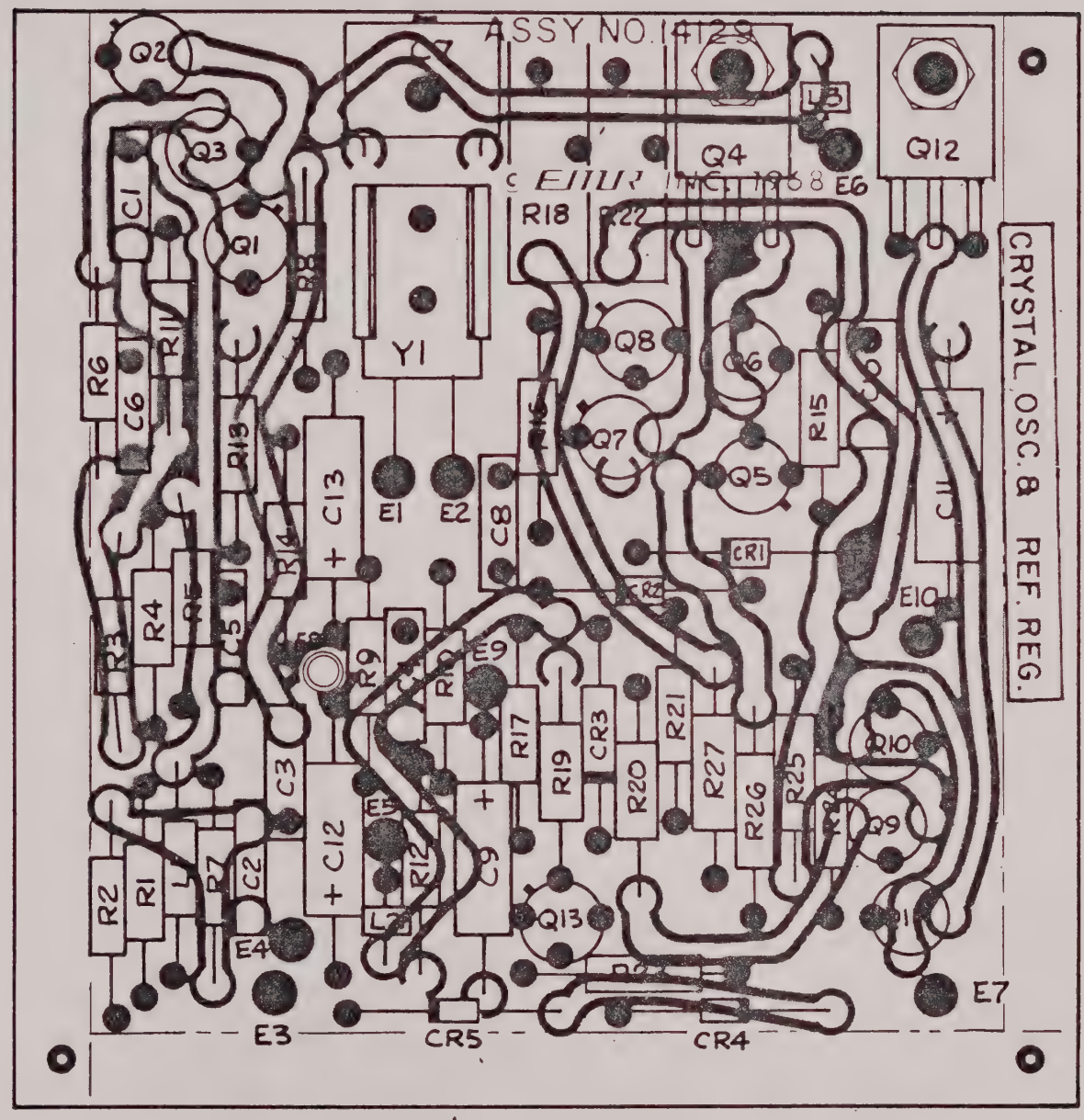


Figure 5-37. VCO and Temperature Regulator Card A4A1A1 Schematic Diagram



EMR DWG. NO. 14129, REV. B

Figure 5-38. Crystal Oscillator and Reference Regulator Card A4A1A2 Location of Components

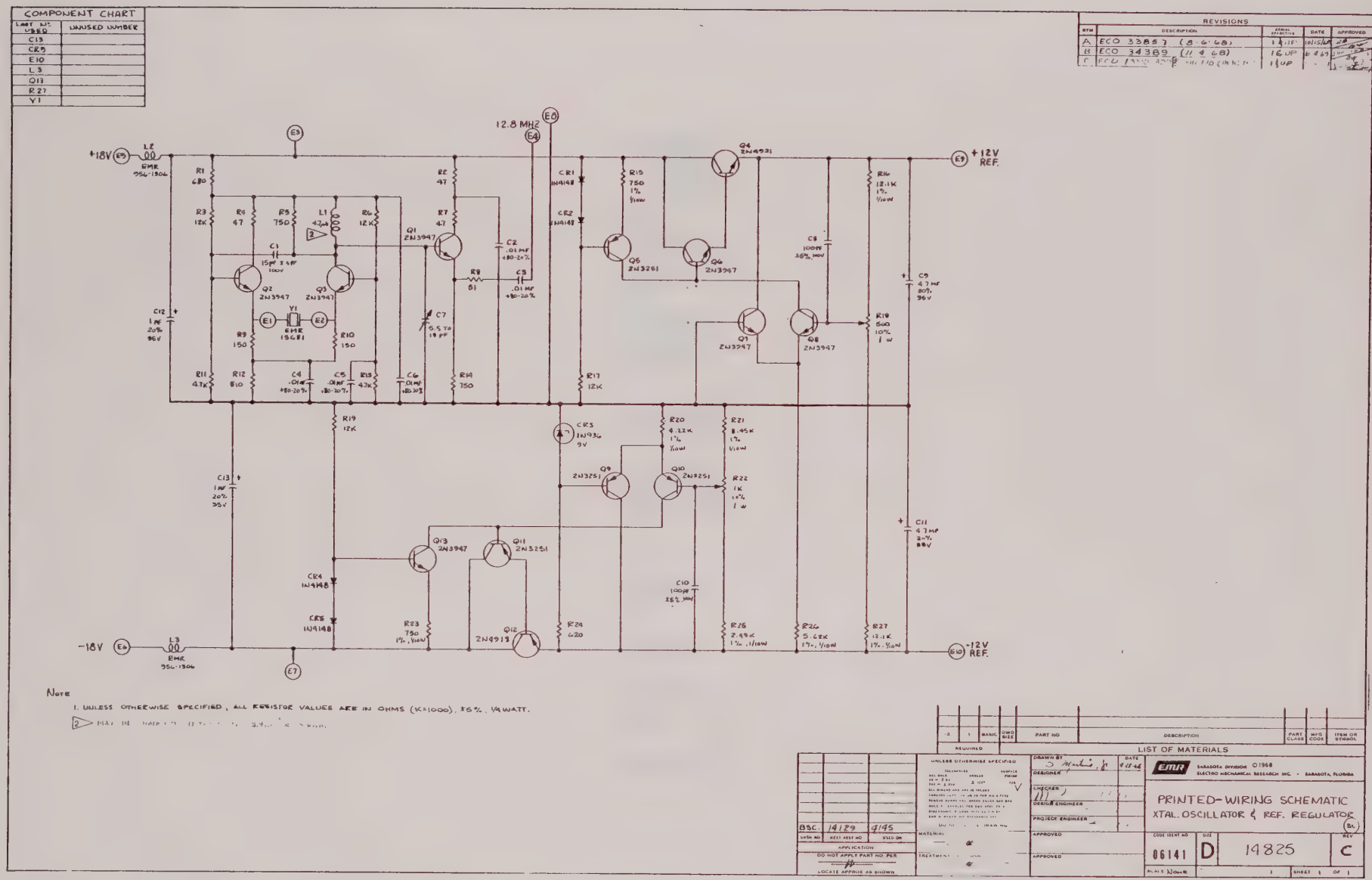


Figure 5-39. Crystal Oscillator and Reference Regulator Card A4A1A2 Schematic Diagram

PARTS LIST

PARTS LIST

SECTION 6

REPLACEABLE PARTS LIST AND RECOMMENDED SPARES

6.1 GENERAL

This section contains a tabular listing, (Table 6-1) by major assembly, of electrical and mechanical parts in the Model 4145 CBW Tunable Discriminator. A detailed component listing of each printed-wiring assembly (card) in the unit is included in Tables 6-2 through 6-15.

Each major assembly in the DESCRIPTION column is identified by an A (assembly) designation in the REF. DESIG. column. (The physical location of each major assembly is shown in Figure 1-2). Other columns include EMR Stock Number, Manufacturers' Code (identified in Table 6-17), Manufacturers' Part Number, and Total Quantity (TQ) used in the unit. The electrical parts listed in Table 6-16 represent the total quantity and total number of recommended spares of multi-used parts in the Model 4145. The recommended spares are based on the following listed conditions: (Paragraph 6.2 describes various other considerations for use as an aid in determining individual provisioning requirements.)

a. Operating time -- 8 hours/day, 5 days/week (2080 hours/year).

b. Operating temperature -- 10°C to 50°C.

c. User has capability to repair to the component level.

d. Failure rates are constant.

e. A 0.9 probability of being able to repair from the recommended complement for one year.

f. Equipment will be used as ground equipment (as opposed to vehicular or airborne).

6.2 PROVISIONING CONSIDERATIONS

The selection of an optimum spare parts complement involves a number of considerations known only to the user. The considerations include operating time and cycles, operating environment, number of equipments to be spared and their locations with respect to one another, urgency of returning an equipment to service, troubleshooting, repair and test capability, stock of commonly used parts, etc.

Sparing considerations known to EMR include mean-time-between-failures for parts and assemblies under various operating environments, prices, relative ease of troubleshooting, repair, retest, etc.

Table 6-18 lists the type of information required in order for EMR to recommend an optimum spare parts complement for specific operating and logistic situations.

If the information outlined in Table 6-18 is supplied to EMR, a recommended list will be furnished at no cost for each individual situation.

6.3 ORDERING INSTRUCTIONS

When ordering parts, complete description of each part as listed in DESCRIPTION column of parts list must accompany order. Also included, must be the EMR stock number and manufacturers' name and part number.

Table 6-1. Model 4145 Tunable CBW Discriminator Parts List (Ref. Figure 5-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	EMR MODEL 4145 TUNABLE CBW DISCRIMINATOR ASSEMBLY	089-89-00038	06141	14982	1		
A1	SUBPANEL ASSEMBLY	191-89-00251	06141	14977	1		
C1	CAPACITOR, POA Variable, (See Figure 2-3)	999-01-00005			1		
CR1 & CR2	DIODE, Ger. Switch, 100V, TRR	088-99-00179	06141	088-99-00179	2		
DS1 thru DS4	LIGHT ASSY., Decimal	155-89-00001	06141	7327	4		
DS5 thru DS8	LIGHT, 28V, 40 Ma	155-98-00011	03797	CFW-22556-06	4		
M1	METER, Edgewise	170-99-00025	06141	16016-5	1		
M2	METER, Edgewise	170-99-00022	06141	16016-2	1		
R1 & R2	POTENTIOMETER, 1K ±5%, .75W	201-98-00077	12697	CM35479	2		
S1	SWITCH ASSY., Rotary	250-89-00001	06141	7632	1		
S2	SWITCH, Rotary, 2P, 5 Pos., 1 Sect., 7/8 Shaft	250-89-00073	06141	19611-29	1		
S3 thru S7	SWITCH, Thumbwheel	250-98-00015	05170	806	5		
S8	SWITCH, Rotary, Modified	250-99-00019	06141	14369	2		
S9	SWITCH ASSY., Thumbwheel	250-89-00007	06141	11604	1		
S10 thru S12	SWITCH, Thumbwheel	250-98-00032	05170	802	3		
S13	SWITCH, Pushbutton, Lited	250-98-00044	97564	1160A7L56-W1-L	1		
	LAMP, T-1-3/4, 28V, .04A	151-02-00001	01121	MS25237-327	1		
S14	Same as S8						
TP1 thru TP4	JACK, Test	143-98-00008	74970	105-251-1	4		
A2	CARD FILE CHASSIS ASSEMBLY	042-89-00086	06141	14980	1		
A2A1	PRINTED-WIRING ASSY., Extender Card	205-89-00501	06141	14199	1		
A2A3	PRINTED-WIRING ASSY., BCD Converter (See Table 6-2 for breakdown)	205-89-00413	06141	14827	1		
A2A4	PRINTED-WIRING ASSY., Binary Counter (See Table 6-3 for breakdown)	205-89-00408	06141	14098	1		
A2A5	PRINTED-WIRING ASSY., Harmonic Selector (See Table 6-4 for breakdown)	205-89-00422	06141	15167	1		

Table 6-1 (Cont'd.). Model 4145 Tunable CBW Discriminator Parts List (Ref. Figure 5-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
A2A6	PRINTED-WIRING ASSY., VCO & HARMONIC MIXER (See Table 6-5 For Breakdown)	205-89-00682	06141	17162	1		
A2A7	PRINTED-WIRING ASSY., LEVEL ADJUST & VCO MODULATOR (See Table 6-6 For Breakdown)	205-89-00675	06141	15155-1	1		
A2A8	PRINTED-WIRING ASSY., DELAY LINE & LOW-PASS (See Table 6-7 For Breakdown)	205-89-00409	06141	14101	1		
A2A9	PRINTED-WIRING ASSY., FIRST IF (See Table 6-8 For Breakdown)	205-89-00414	06141	15146	1		
A2A10	PRINTED-WIRING ASSY., SECOND IF (See Table 6-9 For Breakdown)	205-89-00420	06141	15161	1		
A2A11	PRINTED-WIRING ASSY., DETECTOR (See Table 6-10 For Breakdown)	205-89-00683	06141	17168	1		
A2A12	PRINTED-WIRING ASSY., SINGLE POLE (See Table 6-11 For Breakdown)	205-89-00684	06141	17165	1		
A2A13	PRINTED-WIRING ASSY., POLE PAIR (See Table 6-12 For Breakdown)	205-89-00672	06141	15152-2	1		
A2A14	PRINTED-WIRING ASSY., POLE PAIR (See Table 6-13 For Breakdown)	205-89-00673	06141	15152-3	1		
A2A15	PRINTED-WIRING ASSY., REGULATOR (See Table 6-14 For Breakdown)	205-89-00674	06141	14823-1	1		
A2J1	CONNECTOR, 36 Contacts	063-98-00114	95238	K600-13PCS-CGD36	13		
A2J3 thru A2J15	Same As A2J1						
A3	REAR CONNECTOR PANEL ASSY. (Rev. D)	191-89-00248	06141	6245-9	1		
B1	BLOWER, Venturi Fan	014-98-00001	82877	Gold Seal Muffin	1		
B1	BLOWER, (360 to 440 Hz)	014-98-00005	82877	Type St., Series 810DS	1		
A3C2	CAPACITOR, POA Variable	999-01-00006	06141	999-01-00006	1		

Table 6-1 (Cont'd.). Model 4145 Tunable CBW Discriminator Parts List (Ref. Figure 5-1)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
F1	HOLDER, Fuse	134-98-00006	75915	342004	1		
	FUSE, Slo-Blo, 1-1/2 Amp	120-98-00022	75915	31301.5	1		
J1 thru J4	CONNECTOR, Receptacle, BNC	063-02-00014	01121	UG-1094A/U	4		
J5	CONNECTOR, Plug, 52 Pin, R & P	063-98-00056	02660	220-1N052	1		
J6	CONNECTOR, Receptacle, 3-Wire	063-98-00021	74545	7486	1		
J7	POST, Binding, Grounded	200-98-00003	58474	GP-30NC	1		
J8	POST, Binding, Black Insul.	200-98-00001	58474	DF-30BC	1		
P1 thru P4	CONNECTOR, Plug, BNC	063-02-00011	01121	UG-260/U	4		
P5	CONNECTOR, Receptacle, 52 Pin, R & P	063-98-00063	02660	220-2N052	1		
P6	CONNECTOR, Plug, 3-Wire	063-98-00024	74545	7484	1		
A4	POWER SUPPLY ASSEMBLY (See Table 6-15 For Breakdown)	202-89-00028	06141	14976-2	1		
	CAPACITOR, Male Shorting, Contact	027-98-00001	02660	31-017	1		
	KNOB	999-03-00001	06141	16140	3		
	KNOB	999-03-00002	06141	16140	A/R		
	KNOB	999-03-00004	06141	16140	2		
	KNOB, Locking	999-03-00003	06141	16140	2		

Table 6-2. BCD Converter Printed-Wiring Assembly (A2A3)
Parts List (Rev. B)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	BCD CONVERTER PRINTED-WIRING ASSEMBLY	205-89-00413	06141	14827	1		
C1 & C2	CAPACITOR, 3.3 Mf ±20%, 15V	336-21-33003	06141	601	2		
CR1 & CR2	DIODE	088-10-41480	JEDEC	1N4148	2		
L1	INDUCTOR ASSY.	055-89-00001	06141	956-1306	1		
R1 thru R13	RESISTOR, 16K ±5%, 1/4W	616-02-16001	01121	RC07GF163J	17		
R14	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	1		
R15 thru R18	Same as R1						
R19 thru R23	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	5		
Z1 & Z2	INTEGRATED CIRCUIT	046-14-00002	93332	SG-53-03	4		
Z3 thru Z19	INTEGRATED CIRCUIT	046-14-00009	93332	SF-53-03	18		
Z20	INTEGRATED CIRCUIT	046-14-00003	93332	SG-63-03	1		
Z21 & Z22	Same as Z1						
Z23	INTEGRATED CIRCUIT	046-14-00007	93332	SG-143-03	1		
Z24	INTEGRATED CIRCUIT	046-14-00006	93332	SG-142-03	1		
Z25	Same as Z3						

Table 6-3. Binary Counter Printed-Wiring Assembly (A2A4)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	BINARY COUNTER PRINTED-WIRING ASSEMBLY	205-89-00408	06141	14098	1		
C1 & C2	CAPACITOR, 3.3 Mf ±20%, 15V	336-21-33003	06141	601	2		
L1	INDUCTOR ASSY.	055-89-00001	06141	956-1306	1		
Z1 thru Z22	INTEGRATED CIRCUIT	046-14-00009	93332	SF-53-03	26		
Z23 thru Z25	INTEGRATED CIRCUIT	046-14-00007	93332	SG-143-03	7		
Z26 thru Z29	Same as Z1						
Z30 thru Z32	Same as Z23						
Z33	INTEGRATED CIRCUIT	046-14-00006	93332	SG-142-03	1		
Z34	Same as Z23						

Table 6-4. Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	HARMONIC SELECTOR PRINTED-WIRING ASSEMBLY	205-89-00422	06141	15167	1		
C1 thru C4	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	5		
C5 thru C8	CAPACITOR, .01 Mf −20%+80%, 100V	301-71-10001	72982	805-000 X5 VO 1032	24		
C9	CAPACITOR, .1 Mf ±20%, 50V LS.200	301-13-10002	72982	8131-050-651 104M	7		
C10 thru C13	Same as C5						
C14	CAPACITOR, Trim., 5-25 Pf, 300V	320-98-00016	72982	557-091-39A	2		
C15 thru C21	Same as C5						
C22 & C23	Same as C9						
C24	CAPACITOR, 100 Pf ±1%, 500V	304-20-10009	06141	600	3		
C25	CAPACITOR, 15 Pf ±.5 Pf, 500V	304-01-01509	06141	600	1		
C26	CAPACITOR, 220 Pf ±1%, 500V	304-20-22009	06141	600	1		
C27	Same as C5						
C28	Same as C1						
C29 & C30	CAPACITOR, 130 Pf ±1%, 500V	304-20-13009	06141	600	4		
C31	CAPACITOR, 75 Pf ±1%, 500V	304-13-07509	06141	600	2		
C32	Same as C5						
C33 & C34	Same as C29						
C35	Same as C9						
C36	Same as C31						
C37 thru C42	Same as C5						
C43	Same as C24						
C46	Same as C24						
C47 & C48	CAPACITOR, 910 Pf ±1%, 500V	305-20-91009	06141	600	2		
C49	CAPACITOR, Test Variable						
C50	CAPACITOR, 18 Pf ±.5 Pf, 500V	304-01-01809	06141	600	1		

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
C51	Same as C14						
C52 & C53	Same as C9						
C54	Same as C5						
C55	Same as C49						
C56	CAPACITOR, 27 Pf ±.5 Pf, 500V	304-08-02709	06141	600	1		
CR1 thru CR79	DIODE	088-10-41480	JEDEC	1N4148	80		
CR80	DIODE	088-10-09430	JEDEC	1N943	1		
CR81	DIODE	088-16-00079	04713	MV1642	1		
CR82	Same as CR1						
FL1	FILTER, 20 MHz BP 50 KHz	114-99-00810	06141	11613	1		
L1 thru L4	INDUCTOR ASSY.	055-89-00001	06141	956-1306	4		
L5 thru L8	INDUCTOR, 10.0 µh, 55Q Min.	055-98-00057	99800	1025-44	4		
L9 & L10	INDUCTOR, 33.0 µh, 45Q Min.	055-98-00059	99800	1025-56	2		
L11	INDUCTOR, 2.20 µh, 30Q Min.	055-98-00052	99800	1025-28	1		
M1 & M2	MIXER	431-98-00001	**	M6	2		
Q1 thru Q8	TRANSISTOR	263-10-39470	JEDEC	2N3947	14		
Q9	TRANSISTOR	263-10-36460	JEDEC	2N3646	1		
Q10	Same as Q1						
Q11	TRANSISTOR	263-99-00139	06141	805-1	2		
Q12 thru Q14	Same as Q1						
Q15 & Q16	TRANSISTOR, NPN Dual Amp.	263-16-00179	04713	MD8001	2		
Q17 & Q18	Same as Q1						
Q19	Same as Q11						
R1	RESISTOR, 10 Ohm ±5%, 1/4W	616-02-01009	01121	RC07GF100J	14		
R2	RESISTOR, 47 Ohm ±5%, 1/4W	616-02-04709	01121	RC07GF470J	8		
R3	RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	01121	RC07GF472J	5		
R4	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	3		

** Relcom, 2329 Charleston Rd., Mt. View, Calif.

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R5	Same as R1						
R6	RESISTOR, 200 Ohm ±5%, 1/4W	616-02-20009	01121	RC07GF201J	3		
R7	Same as R1						
R8 & R9	RESISTOR, 270 Ohm ±5%, 1/4W	616-02-27009	01121	RC07GF271J	4		
R10	Same as R6						
R11	Same as R1						
R12 & R13	RESISTOR, 100 Ohm ±5%, 1/4W	616-02-10009	01121	RC07GF101J	6		
R14	Same as R8						
R15	Same as R4						
R16	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	3		
R17	Same as R2						
R18	Same as R3						
R19	Same as R4						
R20	RESISTOR, 51 Ohm ±5%, 1/4W	616-02-05109	01121	RC07GF510J	2		
R21 & R22	Same as R1						
R23	RESISTOR, 15K ±5%, 1/4W	616-02-15001	01121	RC07GF153J	1		
R24	RESISTOR, 680 Ohm ±5%, 1/4W	616-02-68009	01121	RC07GF681J	2		
R25	Same as R2						
R26	RESISTOR, 2K ±5%, 1/4W	616-02-20000	01121	RC07GF202J	1		
R27	RESISTOR, 150 Ohm ±5%, 1/4W	616-02-15009	01121	RC07GF151J	1		
R28	RESISTOR, 33 Ohm ±5%, 1/4W	616-02-03309	01121	RC07GF330J	2		
R29	Same as R24						
R30 & R31	Same as R1						
R32	Same as R2						
R33	RESISTOR, 510 Ohm ±5%, 1/4W	616-02-51009	01121	RC07GF511J	1		
R34	RESISTOR, 220 Ohm ±5%, 1/4W	616-02-22009	01121	RC07GF221J	6		
R35	Same as R1						
R36	Same as R3						
R37	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	2		
R38	RESISTOR, 560 Ohm ±5%, 1/4W	616-02-56009	01121	RC07GF561J	1		
R39	Same as R2						
R40	Same as R34						
R41	Same as R2						

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R42	RESISTOR, 180 Ohm ±5%, 1/4W	616-02-18009	01121	RC07GF181J	1		
R43 & R44	RESISTOR, 330 Ohm ±5%, 1/4W	616-02-33009	01121	RC07GF331J	3		
R45	Same as R12						
R46	Same as R16						
R47	Same as R2						
R48	RESISTOR, 12K ±5%, 1/4W	616-02-12001	01121	RC07GF123J	3		
R49	RESISTOR, 1.2K ±5%, 1/4W	616-02-12000	01121	RC07GF122J	2		
R50	Same as R43						
R51	Same as R1						
R52	Same as R12						
R53	RESISTOR, 5.6K ±5%, 1/4W	616-02-56000	01121	RC07GF562J	2		
R54	Same as R2						
R55	Same as R16						
R56	Same as R48						
R57	Same as R49						
R58	Same as R20						
R59 & R60	RESISTOR, 300 Ohm ±5%, 1/4W	616-02-30009	01121	RC07GF301J	2		
R61	Same as R34						
R62	Same as R1						
R63	Same as R6						
R64	Same as R34						
R65 & R66	RESISTOR, 51.1 Ohm ±1%, 1/8W	605-09-05119	06141	625	2		
R67	RESISTOR, 100 Ohm ±1%, 1/8W	605-09-10009	06141	625	3		
R68	Same as R8						
R69	Same as R1						
R70	Same as R67						
R71 & R72	RESISTOR, 4.64K ±1%, 1/8W	605-09-46400	06141	625	2		
R73 & R74	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	5		
R75	Same as R1						
R76	RESISTOR, 5.11K ±1%, 1/8W	605-09-51100	06141	625	2		
R77	RESISTOR, 1K ±1%, 1/8W	605-09-10000	06141	625	2		
R78	POTENTIOMETER, 100 Ohm + 500PPM 1T	201-98-00136	73138	62PR100	1		
R79	Same as R77						

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R80	Same as R73						
R81	RESISTOR, 4.87K ±1%, 1/8W	605-09-48700	06141	625	2		
R82	Same as R76						
R83	RESISTOR, 47 Ohm ±5%, 1/4W	616-02-04709	01121	RC07GF470J	1		
R84	POTENTIOMETER, 2K ±30%, 1/2W	201-98-00092	73138	62PR2K	3		
R85	Same as R81						
R86	RESISTOR, 604 Ohm ±1%, 1/8W	605-09-60409	06141	625	1		
R87	POTENTIOMETER, 1K ±30%, 1/2W	201-98-00091	73138	62PR1K	1		
R88	Same as R84						
R89	POTENTIOMETER, 5K ±30%, 1/2W	201-98-00093	73138	62PR5K	1		
R90 thru R100	POTENTIOMETER, 10K ±30%, 1/2W	201-98-00149	73138	62PR10K	11		
R101	Same as R84						
R102	RESISTOR, 13.3K ±1%, 1/8W	605-09-13301	06141	625	2		
R103	RESISTOR, 13.7K ±1%, 1/8W	605-09-13701	06141	625	2		
R104	Same as R102						
R105	RESISTOR, 12.4K ±1%, 1/8W	605-09-12401	06141	625	1		
R106	Same as R103						
R107	RESISTOR, 16.2K ±1%, 1/8W	605-09-16201	06141	625	1		
R108	RESISTOR, 17.8K ±1%, 1/8W	605-09-17801	06141	625	1		
R109	RESISTOR, 19.6K ±1%, 1/8W	605-09-19601	06141	625	1		
R110	RESISTOR, 21.5K ±1%, 1/8W	605-09-21501	06141	625	1		
R111	RESISTOR, 26.1K ±1%, 1/8W	605-09-26101	06141	625	1		
R112	RESISTOR, 28.7K ±1%, 1/8W	605-09-28701	06141	625	1		
R113	RESISTOR, 34.0K ±1%, 1/8W	605-09-34001	06141	625	1		
R114	RESISTOR, 39.2K ±1%, 1/8W	605-09-39201	06141	625	1		
R115	RESISTOR, 46.4K ±1%, 1/8W	605-09-46401	06141	625	1		
R116	RESISTOR, 59K ±1%, 1/8W	605-09-59001	06141	625	1		
R117	RESISTOR, 100K ±5%, 1/4W	616-02-10002	01121	RC07GF104J	15		
R118	RESISTOR, 3.3K ±5%, 1/4W	616-02-33000	01121	RC07GF332J	2		
R119	Same as R117						
R120	RESISTOR, 3.6K ±5%, 1/4W	616-02-36000	01121	RC07GF362J	1		
R121	Same as R117						

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R122	RESISTOR, 3.9K ±5%, 1/4W	616-02-39000	01121	RC07GF392J	1		
R123	Same as R117						
R124	Same as R3						
R125	Same as R117						
R126	Same as R3						
R127	Same as R117						
R128	RESISTOR, 5.1K ±5%, 1/4W	616-02-51000	01121	RC07GF512J	1		
R129	Same as R117						
R130	RESISTOR, 6.2K ±5%, 1/4W	616-02-62000	01121	RC07GF622J	2		
R131	Same as R117						
R132	Same as R130						
R133	Same as R117						
R134	RESISTOR, 6.8K ±5%, 1/4W	616-02-68000	01121	RC07GF682J	1		
R135	Same as R117						
R136	RESISTOR, 7.5K ±5%, 1/4W	616-02-75000	01121	RC07GF752J	1		
R137	Same as R117						
R138	RESISTOR, 8.2K ±5%, 1/4W	616-02-82000	01121	RC07GF822J	1		
R139	Same as R117						
R140	RESISTOR, 9.1K ±5%, 1/4W	616-02-91000	01121	RC07GF912J	1		
R141	Same as R117						
R142	Same as R37						
R143	Same as R117						
R144	Same as R48						
R145	Same as R117						
R146	RESISTOR, 13K ±5%, 1/4W	616-02-13001	01121	RC07GF133J	1		
R147	Same as R73						
R149	Same as R67						
R150	POTENTIOMETER, 10K ohm ± 30%, 1/2W	201-98-00149	73138	62PR50	1		
R151	Same as R118						
R152	Same as R73						
R153 & R154	Same as R12						

Table 6-4 (Cont'd.). Harmonic Selector Printed-Wiring Assembly (A2A5)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R155 & R156	Same as R34						
R157 & R158	POTENTIOMETER, 20 Ohm ±30%, 1/2W	201-98-00146	73138	62PR20	2		
R159	Same as R53						
R160	Same as R8						
R161	Same as R1						
TP1 thru TP3	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	3		
Z1 thru Z7	INTEGRATED CIRCUIT	046-16-00002	04713	MC358G/SC 1322A	7		
Z8	INTEGRATED CIRCUIT	046-15-00002	02735	CA3028	1		
Z9 thru Z11	INTEGRATED CIRCUIT	046-97-00001	01295 18324	SN749N N8280A	3		
Z12	PWA, Amplifier	205-89-01735	06141	30471	1		

Table 6-5. VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	VCO AND HARMONIC MIXER PRINTED-WIRING ASSEMBLY	205-89-00682	06141	17162	1		
C1 thru C3	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	10		
C4	CAPACITOR, 162.0 Pf ±1%, 500V	304-20-16209	06141	600	1		
C5 & C6	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	18		
C7 & C8	Same as C1						
C9 & C10	Same as C5						
C11	CAPACITOR, 100 Pf ±1%, 500V	304-20-10009	06141	600	1		
C12	CAPACITOR, 130 Pf ±1%, 500V	304-20-13009	06141	600	5		
C13	CAPACITOR, 91 Pf ±1%, 500V	304-20-09109	06141	600	1		
C14	Same as C5						
C15	CAPACITOR, 24 Pf ±.5 Pf, 500V	304-01-02409	06141	600	1		
C16 & C17	Same as C5						
C18	CAPACITOR, 18 Pf ±.5 Pf, 500V	304-01-01809	06141	600	1		
C19 & C20	Same as C1						
C21 & C22	Same as C5						
C23	CAPACITOR, 15 Pf ±.5 Pf, 500V	304-01-01509	06141	600	1		
C24	CAPACITOR, 27 Pf ±.5 Pf, 500V	304-08-02709	06141	600	1		
C25	Same as C5						
C26	CAPACITOR, 620 Pf ±1%, 300V	304-41-62009	06141	600	4		
C27	CAPACITOR, 43 Pf ±.5 Pf, 500V	304-08-04309	06141	600	2		
C28	Same as C26						
C29	CAPACITOR, .01 Mf -20%+80%, 100V	301-71-10001	72982	805-000 X5VO 103Z	8		
C30	Same as C26						
C31 & C32	Same as C5						
C33	Same as C27						
C34 & C35	Same as C29						
C36	Same as C26						
C37 & C38	Same as C12						
C39	CAPACITOR, 75 Pf ±1%, 500V	304-13-07509	06141	600	2		
C40	Same as C29						

Table 6-5 (Cont'd.). VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
C41 & C42	Same as C12						
C43	Same as C5						
C44	Same as C39						
C45 & C46	Same as C29						
C47	CAPACITOR, 12 Pf ±.5 Pf, 500V	304-01-01209	06141	600	1		
C48	CAPACITOR, 10 Pf ±.5 Pf, 500V	304-01-01009	06141	600	1		
C49 & C50	Same as C1						
C51	CAPACITOR, 22 Pf ±.5 Pf, 500V	304-01-02209	06141	600	1		
C52 & C53	CAPACITOR, Test Variable	304-08-00000	06141	600	2		
C54 thru C58	Same as C5						
C59	Same as C1						
C60 & C61	Same as C29						
CR1 thru CR41	DIODE	088-10-41480	JEDEC	1N4148	41		
K1 thru K5	RELAY, 2 Form A Contacts	219-98-00045	27682	GP-2A-26-P	5		
L1 thru L3	INDUCTOR ASSY.	055-89-00001	06141	956-1306	4		
L4	INDUCTOR, .792 Mh Nom.	453-02-00138	06141	7688-2	1		
L5	INDUCTOR, .804 Mh Nom.	450-02-00069	06141	6944-2	1		
L6	INDUCTOR, 2.01 Mh Nom.	453-02-00139	06141	7688-2	1		
L7	INDUCTOR, .629 Mh Nom.	450-02-00070	06141	6944-2	1		
L8	INDUCTOR, .114 Mh Nom.	453-02-00136	06141	7688-2	1		
L9	INDUCTOR, .202 Mh Nom.	450-02-00067	06141	6944-2	1		
L10	INDUCTOR, .120 Mh Nom.	453-02-00137	06141	7688-2	1		
L11	INDUCTOR, .170 Mh Nom.	450-02-00068	06141	6944-2	1		
L12 thru L16	INDUCTOR, 10.0 μh, 55Q Min.	055-98-00057	99800	1025-44	8		
L17	INDUCTOR, 33.0 μh, 45Q Min.	055-98-00059	99800	1025-56	2		
L18 & L19	Same as L12						
L20	Same as L17						
L21	Same as L12						

Table 6-5 (Cont'd.). VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
L22	INDUCTOR, .049 Mh Nom.	450-02-00071	06141	6944-2	1		
L23	INDUCTOR, .050 Mh Nom.	453-02-00163	06141	7688-2	1		
L24	INDUCTOR, .098 Mh Nom.	450-02-00072	06141	6944-2	1		
L25	INDUCTOR, .058 Mh Nom.	451-02-00062	06141	6945-2	1		
L26	Same as L1						
M1 & M2	MIXER	431-98-00001	**	M6	2		
Q1 thru Q5	TRANSISTOR	263-10-39470	JEDEC	2N3947	5		
Q6 thru Q10	TRANSISTOR	263-10-31160	JEDEC	2N3116	5		
R1	RESISTOR, 2.32K ±1%, 1/8W	605-09-23200	06141	625	2		
R2	RESISTOR, 2.8K ±1%, 1/8W	605-09-28000	06141	625	1		
R3	RESISTOR, 5.76K ±1%, 1/8W	605-09-57600	06141	625	1		
R4 & R5	RESISTOR, 10 Ohm ± 5%, 1/4W	616-02-01009	01121	RC07GF100J	2		
R6	Same as R1						
R7	RESISTOR, 1.78K ±1%, 1/8W	605-09-17800	06141	625	1		
R8	RESISTOR, 2.61K ±1%, 1/8W	605-09-26100	06141	625	1		
R9	RESISTOR, 51 Ohm ±5%, 1/4W	616-02-05109	01121	RC07GF510J	4		
R10	RESISTOR, 9.53K ±1%, 1/8W	605-09-95300	06141	625	1		
R11	RESISTOR, 1.62K ±1%, 1/8W	605-09-16200	06141	625	1		
R12	RESISTOR, 453 Ohm ±1%, 1/8W	605-09-45309	06141	625	1		
R13	RESISTOR, 9.31K ±1%, 1/8W	605-09-93100	06141	625	1		
R14 & R15	Same as R4						
R16	RESISTOR, 1.74K ±1%, 1/8W	605-09-17400	06141	625	1		
R17	RESISTOR, 365 Ohm ±1%, 1/8W	605-09-36509	06141	625	1		
R18	Same as R9						
R19	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	2		
R20	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	11		
R21	Same as R19						
R22	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	5		
R23	RESISTOR, 10 Ohm ±5%, 1/4W	616-02-01009	01121	RC07GF100J	3		
R24	RESISTOR, 5.6K ±5%, 1/4W	616-02-56000	01121	RC07GF562J	3		
R25	RESISTOR, 47 Ohm ±5%, 1/4W	616-02-04709	01121	RC07GF470J	4		

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Table 6-5 (Cont'd.). VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R26	RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	01121	RC07GF472J	3		
R27	RESISTOR, 12K ±5%, 1/4W	616-02-12001	01121	RC07GF123J	3		
R28	RESISTOR, 680 Ohm ±5%, 1/4W	616-02-68009	01121	RC07GF681J	3		
R29	RESISTOR, 100 Ohm ±5%, 1/4W	616-02-10009	01121	RC07GF101J	7		
R30	RESISTOR, 330 Ohm ±5%, 1/4W	616-02-33009	01121	RC07GF331J	2		
R31	Same as R23						
R32	Same as R20						
R33	Same as R24						
R34	Same as R25						
R35	Same as R23						
R36	Same as R24						
R37	Same as R25						
R38	Same as R27						
R39	RESISTOR, 1.2K ±5%, 1/4W	616-02-12000	01121	RC07GF122J	1		
R40	Same as R30						
R41	Same as R20						
R42	Same as R29						
R43	Same as R27						
R44	Same as R28						
R45	Same as R29						
R46	RESISTOR, 487 Ohm ±1%, 1/8W	605-09-48709	06141	625	1		
R48 & R49	Same as R4						
R50	RESISTOR, 2.43K ±1%, 1/8W	605-09-24300	06141	625	1		
R51	RESISTOR, 1.1K ±1%, 1/8W	605-09-11000	06141	625	1		
R52	RESISTOR, 619 Ohm ±1%, 1/8W	605-09-61909	06141	625	1		
R53 thru R62	RESISTOR, 18K ±5%, 1/4W	616-02-18001	01121	RC07GF183J	10		
R63 thru R66	Same as R22						
R67	RESISTOR, 470 Ohm ±5%, 1/4W	616-02-47009	01121	RC07GF471J	1		
R68 thru R74	Same as R20						
R75 & R76	RESISTOR, 1.5K ±5%, 1/4W	616-02-15000	01121	RC07GF152J	3		

Table 6-5 (Cont'd.). VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R77	Same as R20						
R78	RESISTOR, 2.7K ±5%, 1/4W	616-02-27000	01121	RC07GF272J	5		
R79	RESISTOR, 100K ±5%, 1/4W	616-02-10002	01121	RC07GF104J	5		
R80	Same as R78						
R81	Same as R79						
R82	Same as R78						
R83	Same as R79						
R84	Same as R78						
R85	Same as R79						
R86	Same as R78						
R87	Same as R79						
R88 & R89	Same as R9						
R90	RESISTOR, 15K ±5%, 1/4W	616-02-15001	01121	RC07GF153J	1		
R91	Same as R28						
R92	Same as R25						
R93	Same as R75						
R94	RESISTOR, 150 Ohms ±5%, 1/4W	616-02-15009	01121	RC07GF151J	1		
R95	Same as R26						
R96 thru R99	Same as R29						
R100	Same as R26						
R101 thru R105	RESISTOR, 2K, ±5%, 1/4W	616-02-20000	01121	RC07GF202J	5		
TP1 thru TP4	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	4		
Z1	INTEGRATED CIRCUIT	046-89-00010	06141	12182	7		
Z2	INTEGRATED CIRCUIT	046-89-00009	06141	12181	6		
Z3	Same as Z1						
Z4	Same as Z2						
Z5	Same as Z1						
Z6	Same as Z2						
Z7	Same as Z1						
Z8	Same as Z2						

Table 6-5 (Cont'd.). VCO and Harmonic Mixer Printed-Wiring Assembly (A2A6) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
Z9	INTEGRATED CIRCUIT	046-15-00002	02735	CA3028	1		
Z10	Same as Z2						
Z11	Same as Z1						
Z12	Same as Z2						
Z13 & Z14	Same as Z1						

Table 6-6. Input Level Adjust Printed-Wiring Assembly (A2A7)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	INPUT LEVEL ADJUST PRINTED-WIRING ASSEMBLY	205-89-00675	06141	15155-1	1		
C1 thru C3	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	16		
C4	CAPACITOR, 0.1 Mf ±10%, 100V	361-01-10002	06141	809	1		
C5 & C6	Same as C1						
C7 thru C9	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	3		
C10	Same as C1						
C13 thru C16	Same as C1						
C19 thru C24	Same as C1						
CR1 thru CR51	DIODE	088-10-41480	JEDEC	1N4148	51		
K1 thru K4	RELAY, Spst, NC, 26V	219-98-00068	27682	65630-19/GP-1B-26D	4		
K5 thru K8	RELAY, Dpst, NC, 26V	219-98-00069	27682	65630-20/GP-2B-26D	4		
L1 thru L3	INDUCTOR ASSY.	055-89-00001	06141	956-1306	3		
Q1 thru Q5	TRANSISTOR	263-10-39470	JEDEC	2N3947	15		
Q6	TRANSISTOR	263-99-00139	06141	805-1	5		
Q7 thru Q11	Same as Q1						
Q12	Same as Q6						
Q13	Same as Q1						
Q14	Same as Q6						
Q15 thru Q17	Same as Q1						
Q18	Same as Q6						
Q19	Same as Q1						
Q20	Same as Q6						

Table 6-6 (Cont'd.). Input Level Adjust Printed-Wiring Assembly (A2A7) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
Q21 thru Q28	TRANSISTOR	263-10-31160	JEDEC	2N3116	8		
R1 & R2	RESISTOR, 47 Ohm ±5%, 1/4W	616-02-04709	01121	RC07GF470J	7		
R3	RESISTOR, 22K ±5%, 1/4W	616-02-22001	01121	RC07GF223J	2		
R4	RESISTOR, 100 Ohm ±5%, 1/4W	616-02-10009	01121	RC07GF101J	6		
R5	RESISTOR, 9.76K ±1%, 1/8W	605-09-97600	06141	625	1		
R6	Same as R4						
R7	RESISTOR, 4.02K ±1%, 1/8W	605-09-40200	06141	625	2		
R8 thru R10	RESISTOR, 18K ±5%, 1/4W	616-02-18001	01121	RC07GF183J	3		
R11	RESISTOR, 330 Ohm ±5%, 1/4W	616-02-33009	01121	RC07GF331J	2		
R12	RESISTOR, 51 Ohm ±5%, 1/4W	616-02-05109	01121	RC07GF510J	2		
R13	POTENTIOMETER, 20K ±10%, .75W PC Mtg	201-98-00105	73138	79PR20K	1		
R14	RESISTOR, 487 Ohm ±1%, 1/8W	605-09-48709	06141	625	1		
R15	RESISTOR, 2.7K ±5%, 1/4W	616-02-27000	01121	RC07GF272J	11		
R16	RESISTOR, 6.8K ±5%, 1/4W	616-02-68000	01121	RC07GF682J	1		
R17 & R18	RESISTOR, 12K ±5%, 1/4W	616-02-12001	01121	RC07GF123J	2		
R19	Same as R11						
R20	Same as R12						
R21	RESISTOR, 499 Ohm ±1%, 1/8W	605-09-49909	06141	625	1		
R22	RESISTOR, 4.7 Meg Ohm ±5%, 1/4W	616-02-47003	01121	RC07GF475J	2		
R23	Same as R1						
R24	Same as R3						
R25	Same as R4						
R26	Same as R15						
R27	Same as R1						
R28	Same as R15						
R29	RESISTOR, 10 Ohm ±5%, 1/4W	616-02-01009	01121	RC07GF100J	7		
R30	RESISTOR, 4.99K ±1%, 1/8W	605-09-49900	06141	625	1		
R32	RESISTOR, 750 Ohm ± 1%, 1/8W	605-09-75009	06141	625	1		
R34	RESISTOR, 10.0K ± 1%, 1/8W	605-09-10001	06141	625	1		

Table 6-6 (Cont'd.). Input Level Adjust Printed-Wiring Assembly (A2A7) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R35	Same as R29						
R36	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	8		
R37	RESISTOR, 56K ±5%, 1/4W	616-02-56001	01121	RC07GF563J	1		
R38	RESISTOR, 1.5K ±5%, 1/4W	616-02-15000	01121	RC07GF152J	1		
R39 & R40	Same as R1						
R41 & R42	RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	01121	RC07GF472J	10		
R43	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	4		
R44	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	5		
R45	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	5		
R46 & R47	Same as R36						
R48 & R49	Same as R41						
R50	RESISTOR, 27K ±5%, 1/4W	616-02-27001	01121	RC07GF273J	2		
R51	RESISTOR, 33K ±5%, 1/4W	616-02-33001	01121	RC07GF333J	2		
R52	Same as R36						
R53	POTENTIOMETER, 10K ± 10%, .75W PC	201-98-00148	73138	79PR10K	2		
R54	Same as R29						
R55 & R56	Same as R36						
R57	Same as R53						
R58	Same as R44						
R59	RESISTOR, 470 Ohm ±5%, 1/4W	616-02-47009	01121	RC07GF471J	3		
R60	Same as R36						
R61	RESISTOR, 100K ±5%, 1/4W	616-02-10002	01121	RC07GF104J	5		
R62	Same as R45						
R63	Same as R59						
R64	POTENTIOMETER, 10K ±10%, .75W PC Mtg	201-98-00148	73138	79PR10K	1		
R65	Same as R41						
R66	Same as R43						
R67	Same as R45						
R68	Same as R44						
R69	RESISTOR 9.31K ±1%, 1/8W	605-09-93100	06141	625	1		
R70	POTENTIOMETER, 1K ±10%, .75W PC Mtg	201-98-00138	73138	79PR1K	1		
R71	RESISTOR, 1.47K ±1%, 1/8W	605-09-14700	06141	625	1		
R72	POTENTIOMETER, 100 Ohm ±10%, .75W	201-98-00145	73138	79PR100	1		

Table 6-6 (Cont'd.). Input Level Adjust Printed-Wiring Assembly (A2A7) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R73 & R74	Same as R29						
R75	RESISTOR, 15K ±5%, 1/4W	616-02-15001	01121	RC07GF153J	1		
R76	Same as R1						
R77	Same as R4						
R78	RESISTOR, 3.3K ±5%, 1/4W	616-02-33000	01121	RC07GF332J	1		
R79	RESISTOR, 150 Ohm ±5%, 1/4W	616-02-15009	01121	RC07GF151J	1		
R80	RESISTOR, 41.2K ±1%, 1/8W	605-09-41201	06141	625	1		
R81	Same as R7						
R82	RESISTOR, 8.06K ±1%, 1/8W	605-09-80600	06141	625	1		
R83	RESISTOR, 16.2K ±1%, 1/8W	605-09-16201	06141	625	1		
R84	RESISTOR, 32.4K ±1%, 1/8W	605-09-32401	06141	625	1		
R85	RESISTOR, 64.9K ±1%, 1/8W	605-09-64901	06141	625	1		
R86	RESISTOR, 5.9K ±1%, 1/8W	605-09-59000	06141	625	1		
R87	RESISTOR, 130K ±1%, 1/8W	605-09-13002	06141	625	1		
R88	RESISTOR, 11.8K ±1%, 1/8W	605-09-11801	06141	625	1		
R89	RESISTOR, 261K ±1%, 1/8W	605-09-26102	06141	625	1		
R90	RESISTOR, 23.7K ±1%, 1/8W	605-09-23701	06141	625	1		
R91	RESISTOR, 499K ±1%, 1/8W	605-09-49902	06141	625	1		
R92	RESISTOR, 47.5K ±1%, 1/8W	605-09-47501	06141	625	1		
R93	RESISTOR, 680 Ohm ±5%, 1/4W	616-02-68009	01121	RC07GF681J	1		
R94	RESISTOR, 68 Ohm ±5%, 1/4W	616-02-06809	01121	RC07GF680J	1		
R95	RESISTOR, 110 Ohm ±5%, 1/4W	616-02-11009	01121	RC07GF111J	1		
R96	RESISTOR, 240 Ohm ±5%, 1/4W	616-02-24009	01121	RC07GF241J	1		
R97	RESISTOR, 300 Ohm ±5%, 1/4W	616-02-30009	01121	RC07GF301J	2		
R98	Same as R59						
R99	RESISTOR, 750 Ohm ±5%, 1/4W	616-02-75009	01121	RC07GF751J	1		
R100	RESISTOR, 510 Ohm ±5%, 1/4W	616-02-51009	01121	RC07GF511J	2		
R101	RESISTOR, 24K ±5%, 1/4W	616-02-24001	01121	RC07GF243J	1		
R102	RESISTOR, 95.3K ±1%, 1/8W	605-09-95301	06141	625	1		
R103	RESISTOR, 191K ±1%, 1/8W	605-09-19102	06141	625	1		
R104	RESISTOR, 383K ±1%, 1/8W	605-09-38302	06141	625	1		
R105	RESISTOR, 475K ±1%, 1/8W	605-09-47502	06141	625	1		
R106	Same as R4						

Table 6-6 (Cont'd.). Input Level Adjust Printed-Wiring Assembly (A2A7) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R107	Same as R29						
R108	Same as R4						
R109	RESISTOR, 220 Ohm ±5%, 1/4W	616-02-22009	01121	RC07GF221J	1		
R110	Same as R97						
R111	Same as R100						
R112	RESISTOR, 1.6K ±5%, 1/4W	616-02-16000	01121	RC07GF162J	1		
R113	RESISTOR, 3K ±5%, 1/4W	616-02-30000	01121	RC07GF302J	1		
R114	Same as R36						
R115	RESISTOR, 294K ±1%, 1/8W	605-09-29402	06141	625	1		
R116	RESISTOR, 5.9K ±1%, 1/8W	605-09-59000	06141	625	1		
R117 & R118	Same as R41						
R119	Same as R43						
R120	Same as R44						
R121	Same as R45						
R122	Same as R61						
R123	RESISTOR, 21K ±1%, 1/8W	605-09-21001	06141	625	1		
R124	Same as R61						
R125	RESISTOR, 42.2K ±1%, 1/8W	605-09-42201	06141	625	1		
R126	Same as R61						
R127	RESISTOR, 84.5K ±1%, 1/8W	605-09-84501	06141	625	1		
R128	Same as R61						
R129	RESISTOR, 169K ±1%, 1/8W	605-09-16902	06141	625	1		
R130	Same as R41						
R131	RESISTOR, 3.0 Meg Ohm ±5%, 1/4W	616-02-30003	01121	RC07GF305J	1		
R132	Same as R41						
R133	Same as R50						
R134	Same as R51						
R135	POTENTIOMETER, 50K ±10%, .75W PC Mtg	201-98-00106	73138	79PR50K	1		
R136	Same as R22						
R137	Same as R41						
R138	Same as R43						
R139	Same as R45						

Table 6-6 (Cont'd.). Input Level Adjust Printed-Wiring Assembly (A2A7) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R140	Same as R44						
R141 thru R148	Same as R15						
R149	Same as R29						
TP1 thru TP4	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	4		
Z1 & Z2	PWA, Amplifier	205-89-01735	06141	30471	2		

Table 6-7. Delay Line & Low Pass Printed-Wiring Assembly (A2A8) Parts List (Rev. J)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	DELAY LINE & LOW PASS PRINTED-WIRING ASSEMBLY	205-89-00409	06141	14101	1		
C1 thru C3	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	35		
C4	CAPACITOR, 256 Pf ±1%, 500V	304-20-25609	06141	600	1		
C5	CAPACITOR, 1200 Pf ±1%, 500V	305-20-12000	06141	600	2		
C6	CAPACITOR, 2400 Pf ±1%, 500V	305-20-24000	06141	600	1		
C7	CAPACITOR, 165 Pf ±1%, 500V	304-20-16509	06141	600	1		
C8 thru C12	Same as C1						
C13 thru C16	CAPACITOR, 130 Pf ±1%, 500V	304-20-13009	06141	600	36		
C17 thru C19	Same as C1						
C20	CAPACITOR, 129 Pf ±1%, 500V	304-20-12909	06141	600	1		
C21	CAPACITOR, 585 Pf ±1%, 300V	304-41-58509	06141	600	1		
C22	Same as C5						
C23	CAPACITOR, 75 Pf ±1%, 500V	304-13-07509	06141	600	1		
C24 thru C31	Same as C1						
C32	CAPACITOR, 64 Pf ±1%, 500V	304-13-06409	06141	600	1		
C33	CAPACITOR, 296 Pf ±1%, 500V	304-20-29609	06141	600	1		
C34	CAPACITOR, 600 Pf ±1%, 300V	304-41-60009	06141	600	1		
C35	CAPACITOR, 36 Pf ±.5 Pf, 500V	304-08-03609	06141	600	1		
C36 & C37	Same as C1						
C38 & C39	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	2		
C40 thru C44	Same as C1						
C46	Same as C1						
C47	CAPACITOR, 30 Pf ±.5 Pf, 500V	304-08-03009	06141	600	1		
C48	CAPACITOR, 150 Pf ±1%, 500V	304-20-15009	06141	600	2		
C49	CAPACITOR, 300 Pf ±1%, 500V	304-20-30009	06141	600	1		

Table 6-7 (Cont'd.). Delay Line & Low Pass Printed-Wiring Assembly (A2A8) Parts List (Rev. J)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
C50	CAPACITOR, 15 Pf ±.5 Pf, 500V	304-01-01509	06141	600	1		
C51 thru C56	Same as C1						
C57	CAPACITOR, 16 Pf ±.5 Pf, 500V	304-01-01609	06141	600	1		
C58	CAPACITOR, 75 Pf ±1%, 500V	304-13-07509	06141	600	1		
C59	Same as C48						
C60	Same as C1						
C61 thru C91	Same as C13						
C92	Same as C1						
CR1 thru CR20	DIODE	088-10-41480	JEDEC	1N4148	20		
L1	INDUCTOR, .087 Mh ±1%	453-02-00140	06141	7688-2	1		
L2 thru L35	INDUCTOR, .142 Mh ±1%	453-02-00141	06141	7688-2	34		
L37	INDUCTOR, .056 Mh ±1%	453-02-00142	06141	7688-2	1		
L38	INDUCTOR, .750 Mh ±1%	454-02-00019	06141	13777-2	1		
L39	INDUCTOR, 1.63 Mh ±1%	454-02-00020	06141	13777-2	1		
L40	INDUCTOR, 3.30 Mh Nom.	454-02-00021	06141	13777-2	1		
L41	INDUCTOR, .375 Mh ±1%	454-02-00022	06141	13777-2	1		
L42	INDUCTOR, .815 Mh ±1%	454-02-00023	06141	13777-2	1		
L43	INDUCTOR, 1.65 Mh Nom.	454-02-00024	06141	13777-2	1		
L44	INDUCTOR, .188 Mh ±1%	454-02-00025	06141	13777-2	1		
L45	INDUCTOR, .407 Mh ±1%	454-02-00026	06141	13777-2	1		
L46	INDUCTOR, .825 Mh Nom.	454-02-00027	06141	13777-2	1		
L47	INDUCTOR, .094 Mh ±1%	454-02-00028	06141	13777-2	1		
L48	INDUCTOR, .204 Mh ±1%	454-02-00029	06141	13777-2	1		
L49	INDUCTOR, .413 Mh Nom.	454-02-00030	06141	13777-2	1		
L50	INDUCTOR, .047 Mh ±1%	454-02-00031	06141	13777-2	1		
L51	INDUCTOR, .102 Mh ±1%	454-02-00032	06141	13777-2	1		
L52 & L53	INDUCTOR ASSY.	055-89-00001	06141	956-1306	2		
Q1	TRANSISTOR	263-10-39470	JEDEC	2N3947	6		
Q2 & Q3	TRANSISTOR	263-99-00139	06141	805-1	6		
Q4	Same as Q1						
Q5	Same as Q2						
Q6	Same as Q1						

Table 6-7 (Cont'd.). Delay Line & Low Pass Printed-Wiring Assembly (A2A8) Parts List (Rev. J)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
Q7	Same as Q2						
Q8 & Q9	Same as Q1						
Q10	Same as Q2						
Q11	Same as Q1						
Q12	Same as Q2						
R1 & R2	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	24		
R3 & R4	RESISTOR, 100 Ohms ±5%, 1/4W	616-02-10009	01121	RC07GF101J	22		
R5	RESISTOR, 2.7K ±5%, 1/4W	616-02-27000	01121	RC07GF272J	12		
R6	RESISTOR, 18K ±5%, 1/4W	616-02-18001	01121	RC07GF183J	10		
R7	RESISTOR, 1K ±1%, 1/8W	605-09-10000	06141	625	5		
R8	RESISTOR, 332 Ohms ±1%, 1/8W	605-09-33209	06141	625	4		
R9	Same as R5						
R10	Same as R3						
R11	Same as R6						
R12	Same as R3						
R13 thru R15	Same as R1						
R16	Same as R5						
R17 & R18	Same as R1						
R19	Same as R6						
R20	Same as R3						
R21	RESISTOR, 1.05K ±1%, 1/8W	605-09-10500	06141	625	2		
R22	Same as R3						
R23	Same as R5						
R24	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	1		
R25	Same as R7						
R26	Same as R8						
R27	Same as R5						
R28	Same as R3						
R29	Same as R6						
R30	Same as R3						
R31 & R32	Same as R1						
R33	Same as R3						

Table 6-7 (Cont'd.). Delay Line & Low Pass Printed-Wiring Assembly (A2A8) Parts List (Rev. J)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R34 thru R36	Same as R1						
R37	Same as R3						
R38	Same as R1						
R39	Same as R3						
R40	Same as R5						
R41	Same as R6						
R42	Same as R3						
R43	Same as R7						
R44	Same as R8						
R45	Same as R5						
R46	Same as R3						
R47	Same as R6						
R48	Same as R5						
R49 & R50	Same as R1						
R51	Same as R3						
R52 thru R54	Same as R1						
R55 & R56	Same as R3						
R57	Same as R5						
R58	Same as R7						
R59	Same as R8						
R60	Same as R6						
R61	Same as R5						
R62	Same as R3						
R63	Same as R6						
R64	Same as R21						
R65 & R66	Same as R1						
R67	Same as R3						
R68 & R69	Same as R1						
R70	Same as R6						
R71 & R72	Same as R3						
R73	Same as R5						

Table 6-7 (Cont'd.). Delay Line & Low Pass Printed-Wiring Assembly (A2A8) Parts List (Rev. J)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R74	Same as R7						
R75	Same as R5						
R76	Same as R3						
R77	Same as R6						
R78 & R79	Same as R1						
R80	Same as R3						

Table 6-8. First IF Printed-Wiring Assembly (A2A9)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	FIRST IF PRINTED-WIRING ASSEMBLY	205-89-00414	06141	15146	1		
C1	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	17		
C2 thru C4	CAPACITOR, .1 Mf +80%−20%, 50V	301-14-10002	72982	8131-050-651-104Z	47		
C5	Same as C1						
C6 thru C8	Same as C2						
C9 & C10	Same as C1						
C11	Same as C2						
C12	CAPACITOR, 470 Pf ±1%, 500V	304-20-47009	06141	600	4		
C13	Same as C2						
C14 & C15	Same as C12						
C16	Same as C2						
C17	Same as C12						
C18 & C19	Same as C1						
C20 thru C22	Same as C2						
C23	Same as C1						
C24	Same as C2						
C25	CAPACITOR, 360 Pf ±1%, 500V	304-20-36009	06141	600	3		
C26 & C27	Same as C2						
C28	Same as C25						
C29	CAPACITOR, 300 Pf ±1%, 500V	304-20-30009	06141	600	1		
C30 & C31	Same as C2						
C32	Same as C25						
C33 & C34	Same as C1						
C35 & C36	Same as C2						
C37 & C38	Same as C1						
C39	CAPACITOR, 180 Pf ±1%, 500V	304-20-18009	06141	600	2		
C40 & C41	Same as C2						
C42	Same as C39						
C43	CAPACITOR, 150 Pf ±1%, 500V	304-20-15009	06141	600	1		
C44 & C45	Same as C2						

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
C46	CAPACITOR, 160 Pf ±1%, 500V	304-20-16009	06141	600	1		
C47 & C48	Same as C1						
C49	Same as C2						
C50	CAPACITOR, 82 Pf ±1%, 500V	304-13-08209	06141	600	2		
C51	CAPACITOR, 30 Pf ±.5 Pf, 500V	304-08-03009	06141	600	4		
C52 thru C55	Same as C2						
C56	Same as C50						
C57 & C58	Same as C51						
C59 & C60	Same as C2						
C61	Same as C51						
C62 & C63	Same as C1						
C64 thru C79	Same as C2						
C80	CAPACITOR, 75 Pf ±1%, 500V	304-13-07509	06141	600	2		
C81 & C82	Same as C1						
C83	Same as C80						
C84	CAPACITOR, 2.2 Mf ±20%, 50V	301-23-22003	72982	8141-050-225M	1		
C85	Same as C2						
CR1 thru CR64	DIODE	088-10-41480	JEDEC	1N4148	64		
L1 & L2	INDUCTOR ASSY.	055-89-00001	06141	956-1306	2		
L3	INDUCTOR, 1.17 Mh Nom.	453-02-00159	06141	7688-2	1		
L4	INDUCTOR, 1.09 Mh Nom.	453-02-00160	06141	7688-2	1		
L5	INDUCTOR, 1.04 Mh Nom.	453-02-00161	06141	7688-2	1		
L6	INDUCTOR, 1.23 Mh Nom.	453-02-00162	06141	7688-2	1		
L7	INDUCTOR, .380 Mh Nom.	453-02-00143	06141	7688-2	1		
L8	INDUCTOR, .354 Mh Nom.	453-02-00144	06141	7688-2	1		
L9	INDUCTOR, .403 Mh Nom.	453-02-00145	06141	7688-2	1		
L10	INDUCTOR, .399 Mh Nom.	453-02-00146	06141	7688-2	1		
L11	INDUCTOR, .185 Mh Nom.	453-02-00155	06141	7688-2	1		
L12	INDUCTOR, .173 Mh Nom.	453-02-00156	06141	7688-2	1		
L13	INDUCTOR, .195 Mh Nom.	453-02-00157	06141	7688-2	1		

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
L14	INDUCTOR, .217 Mh Nom.	453-02-00158	06141	7688-2	1		
L15	INDUCTOR, .095 Mh Nom.	453-02-00151	06141	7688-2	1		
L16	INDUCTOR, .089 Mh Nom.	453-02-00152	06141	7688-2	1		
L17	INDUCTOR, .092 Mh Nom.	453-02-00153	06141	7688-2	1		
L18	INDUCTOR, .109 Mh Nom.	453-02-00154	06141	7688-2	1		
L19	INDUCTOR, .055 Mh Nom.	453-02-00147	06141	7688-2	1		
L20	INDUCTOR, .051 Mh Nom.	453-02-00148	06141	7688-2	1		
L21	INDUCTOR, .049 Mh Nom.	453-02-00149	06141	7688-2	1		
L22	INDUCTOR, .058 Mh Nom.	453-02-00150	06141	7688-2	1		
Q1 & Q2	TRANSISTOR	263-10-39470	JEDEC	2N3947	15		
Q3	TRANSISTOR	263-99-00139	06141	805-1	4		
Q4	Same as Q1						
Q5	Same as Q3						
Q6 thru Q9	Same as Q1						
Q10	Same as Q3						
Q11	Same as Q1						
Q12	Same as Q3						
Q13 thru Q19	Same as Q1						
R1	RESISTOR, 5.6K ±5%, 1/4W	616-02-56000	01121	RC07GF562J	3		
R2	POTENTIOMETER, 100 Ohm ±10%, .75W	201-98-00145	73138	79PR100	2		
R3	RESISTOR, 649 Ohm ±1%, 1/8W	605-09-64909	06141	625	2		
R4	RESISTOR, 470 Ohm ±5%, 1/4W	616-02-47009	01121	RC07GF471J	7		
R5	RESISTOR, 10 Ohm ±5%, 1/4W	616-02-01009	01121	RC07GF100J	21		
R6	RESISTOR, 47 Ohm ±5%, 1/4W	616-02-04709	01121	RC07GF470J	5		
R7	Same as R4						
R8	RESISTOR, 33 Ohm ±5%, 1/4W	616-02-03309	01121	RC07GF330J	4		
R9	Same as R6						
R10	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	22		
R11	Same as R5						
R12	Same as R10						
R13	RESISTOR, 15K ±1%, 1/8W	605-09-15001	06141	625	1		

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R14	RESISTOR, 14.7K ±1%, 1/8W	605-09-14701	06141	625	1		
R15	RESISTOR, 5.23K ±1%, 1/8W	605-09-52300	06141	625	1		
R16	RESISTOR, 5.9K ±1%, 1/8W	605-09-59000	06141	625	1		
R17	RESISTOR, 51 Ohm ±5%, 1/4W	616-02-05109	01121	RC07GF510J	5		
R18 & R19	Same as R5						
R20 & R21	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	11		
R22	Same as R10						
R23	Same as R1						
R24	Same as R2						
R25	Same as R3						
R26	Same as R4						
R27	Same as R5						
R28	POTENTIOMETER, 20 Ohm ±30%, 1/2W	201-98-00146	73138	62PR20	2		
R29	Same as R6						
R30	Same as R4						
R31	Same as R8						
R32	Same as R6						
R33	Same as R10						
R34	Same as R5						
R35 & R36	Same as R10						
R37 & R38	Same as R5						
R39	RESISTOR, 680 Ohm ±5%, 1/4W	616-02-68009	01121	RC07GF681J	1		
R40	Same as R6						
R41	RESISTOR, 3.3K ±5%, 1/4W	616-02-33000	01121	RC07GF332J	2		
R42	RESISTOR, 681 Ohm ±1%, 1/8W	605-09-68109	06141	625	2		
R43	RESISTOR, 620 Ohm ±5%, 1/4W	616-02-62009	01121	RC07GF621J	4		
R44	Same as R8						
R45	Same as R4						
R46 thru R50	Same as R10						
R51	RESISTOR, 9.31K ±1%, 1/8W	605-09-93100	06141	625	3		
R52	RESISTOR, 9.09K ±1%, 1/8W	605-09-90900	06141	625	3		
R53	RESISTOR, 3.74K ±1%, 1/8W	605-09-37400	06141	625	2		

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R54	RESISTOR, 3.48K ±1%, 1/8W	605-09-34800	06141	625	1		
R55	Same as R17						
R56 & R57	Same as R5						
R58 & R59	Same as R20						
R60 & R61	RESISTOR, 100K ±5%, 1/4W	616-02-10002	01121	RC07GF104J	9		
R62	Same as R41						
R63	Same as R43						
R64	Same as R42						
R65	Same as R8						
R66	Same as R4						
R67 thru R71	Same as R10						
R72	Same as R1						
R73	RESISTOR, Test Variable	616-02-00000			1		
R74	RESISTOR, 2.7K ±5%, 1/4W	616-02-27000	01121	RC07GF272J	1		
R75	RESISTOR, 220 Ohm ±5%, 1/4W	616-02-22009	01121	RC07GF221J	2		
R76	Same as R5						
R77	Same as R51						
R78	Same as R52						
R79	Same as R53						
R80	RESISTOR, 3.92K ±1%, 1/8W	605-09-39200	06141	625	1		
R81	Same as R17						
R82 & R83	Same as R5						
R84 & R85	Same as R20						
R86 & R87	Same as R60						
R88	Same as R75						
R89	Same as R20						
R90 & R91	Same as R5						
R92	Same as R51						
R93	Same as R52						
R94	RESISTOR, 3.24K ±1%, 1/8W	605-09-32400	06141	625	1		
R95	RESISTOR, 3.57K ±1%, 1/8W	605-09-35700	06141	625	1		
R96	Same as R17						

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R97 & R98	Same as R5						
R99 & R100	Same as R20						
R101 & R102	Same as R60						
R103	Same as R5						
R104	RESISTOR, 10.5K ±1%, 1/8W	605-09-10501	06141	625	1		
R105	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	1		
R106	RESISTOR, 3.16K ±1%, 1/8W	605-09-31600	06141	625	1		
R107	RESISTOR, 3.40K ±1%, 1/8W	605-09-34000	06141	625	1		
R108	Same as R17						
R109 & R110	Same as R5						
R111 & R112	Same as R20						
R113 & R114	Same as R60						
R115	Same as R10						
R116	RESISTOR, 100 Ohm ±5%, 1/4W	616-02-10009	01121	RC07GF101J	13		
R117 & R118	Same as R43						
R119	Same as R116						
R120 & R121	Same as R10						
R122	Same as R4						
R123	Same as R116						
R124	Same as R5						
R125	Same as R10						
R126 thru R135	RESISTOR, 10 Ohm, ±5%, 1/4W	616-02-01009	01121	RC07GF100J	2		
R136 & R137	Same as R10						
R138	Same as R60						

Table 6-8 (Cont'd.). First IF Printed-Wiring Assembly (A2A9)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R139	Same as R28						
Z1	INTEGRATED CIRCUIT ASSY.	046-89-00010	06141	12182	10		
Z2	INTEGRATED CIRCUIT ASSY.	046-89-00009	06141	12181	10		
Z3	Same as Z1						
Z4	Same as Z2						
Z5	Same as Z1						
Z6	Same as Z2						
Z7	Same as Z1						
Z8	Same as Z2						
Z9	Same as Z1						
Z10	Same as Z2						
Z11	Same as Z1						
Z12	Same as Z2						
Z13	Same as Z1						
Z14	Same as Z2						
Z15	Same as Z1						
Z16	Same as Z2						
Z17	Same as Z1						
Z18	Same as Z2						
Z19	Same as Z1						
Z20	Same as Z2						
Z21 thru Z24	INTEGRATED CIRCUIT	046-16-00002	04713	MC358G/SC 1322A	9		
Z25 & Z26	INTEGRATED CIRCUIT	046-16-00003	04713	MC360G	5		
Z27	INTEGRATED CIRCUIT	046-16-00005	04713	MC354G	1		
Z28 thru Z32	Same as Z21						
Z33 thru Z35	Same as Z25						

Table 6-9. Second IF Printed-Wiring Assembly (A2A10)
Parts List (Rev. D)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	SECOND IF PRINTED-WIRING ASSEMBLY	205-89-00420	06141	15161	1		
C1 thru C10	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	10		
C11 thru C21	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	11		
CR1 thru CR30	DIODE	088-10-41480	JEDEC	1N4148	30		
FL1	PWA, BPIF 4 PP 256 KHz 6.25%	475-01-00005	06141	13754	1		
FL2	PWA, BPIF 4 PP 128 KHz 6.25%	475-01-00004	06141	13754	1		
FL3	PWA, BPIF 4 PP 64 KHz 6.25%	475-01-00003	06141	13754	1		
FL4	PWA, BPIF 4 PP 32 KHz 6.25%	475-01-00002	06141	13754	1		
FL5	PWA, BPIF 4 PP 16 KHz 6.25%	475-01-00001	06141	13754	1		
Q1 & Q2	TRANSISTOR	263-10-39470	JEDEC	2N3947	2		
R1	RESISTOR, 360 Ohm ±5%, 1/4W	616-02-36009	01121	RC07GF361J	10		
R2	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	10		
R3	Same as R1						
R4	Same as R2						
R5	RESISTOR, 100 Ohm ±5%, 1/4W	616-02-10009	01121	RC07GF101J	10		
R6	Same as R1						
R7	Same as R2						
R8	Same as R1						
R9	Same as R2						
R10	Same as R5						
R11	Same as R1						
R12	Same as R2						
R13	Same as R1						
R14	Same as R2						
R15	Same as R5						
R16	Same as R1						
R17	Same as R2						
R18	Same as R1						
R19	Same as R2						
R20	Same as R5						

Table 6-9 (Cont'd.). Second IF Printed-Wiring Assembly (A2A10)
Parts List (Rev. D)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R21	Same as R1						
R22	Same as R2						
R23	Same as R1						
R24	Same as R2						
R25 thru R30	Same as R5						
R31	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	4		
R32	RESISTOR, 3.6K ±5%, 1/4W	616-02-36000	01121	RC07GF362J	2		
R33 thru R35	Same as R31						
R36	Same as R32						

Table 6-10. Detector Printed-Wiring Assembly (A2A11)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	DETECTOR PRINTED-WIRING ASSEMBLY	205-89-00683	06141	17168	1		
C1 thru C3	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	11		
C4	CAPACITOR, 18 Pf ±.5 Pf, 500V	304-01-01809	06141	600	1		
C5 & C6	Same as C1						
C7	CAPACITOR, 3.3 Mf ±20%, 15V	336-21-33003	06141	601	6		
C8 thru C10	CAPACITOR, 39 Pf ±.5 Pf, 500V	304-08-03909	06141	600	8		
C11	CAPACITOR, 68 Pf ±1%, 500V	304-13-06809	06141	600	2		
C12 & C13	Same as C7						
C14	Same as C1						
C15	Same as C7						
C16 & C17	Same as C8						
C18 & C19	CAPACITOR, 10 Pf ±.5 Pf, 500V	304-01-01009	06141	600	2		
C20	Same as C8						
C21	CAPACITOR, 2500 Pf ±1%, 500V	305-20-25000	06141	600	1		
C22 & C23	Same as C7						
C24 thru C26	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	4		
C27	Same as C1						
C28	Same as C8						
C29	CAPACITOR, 160 Pf ±1%, 500V	304-20-16009	06141	600	1		
C30	CAPACITOR, 22.0 Mf ±20%, 15V	337-21-22004	06141	601	2		
C31	Same as C8						
C32	Same as C11						
C33	Same as C30						
C34 thru C37	Same as C1						
C38	Same as C24						
CR1	DIODE	088-99-00329	06141	642-07	1		
CR2	DIODE	088-99-00109	06141	642-04	1		
CR3	DIODE	088-99-00099	06141	642-00	2		
CR4 thru CR13	DIODE	088-10-41480	JEDEC	1N4148	16		
CR14	Same as CR3						

Table 6-10 (Cont'd.). Detector Printed-Wiring Assembly (A2A11) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
CR15 & CR16	Same as CR4						
CR17 & CR18	DIODE (Aged)	088-10-09430	JEDEC	1N943	2		
CR19 & CR20	Same as CR4						
CR21 & CR22	DIODE	088-10-48290	JEDEC	1N4829	2		
K1 thru K5	RELAY, 2 Form A Contacts	219-98-00055	95073	24MC-2A	5		
L1 thru L4	INDUCTOR ASSY.	055-89-00001	06141	956-1306	5		
L5	INDUCTOR ASSY.	055-89-00002	06141	15172	1		
L6	Same as L1						
Q1	TRANSISTOR, NPN, Dual Ampl.	263-16-00179	04713	MD8001	2		
Q2 & Q3	TRANSISTOR	263-10-39470	JEDEC	2N3947	5		
Q4 thru Q8	TRANSISTOR (Q6 & Q8, Aged)	263-99-00139	06141	805-1	10		
Q9	Same as Q1 (Aged)						
Q10	Same as Q2						
Q12	TRANSISTOR (Aged)	263-10-36460	JEDEC	2N3646	8		
Q13	Same as Q2						
Q14	Same as Q4						
Q16 & Q17	Same as Q4						
Q18	Same as Q2						
Q20 thru Q24	Same as Q12						
Q25 & Q26	Same as Q4						
Q27 & Q28	Same as Q12 (Q28, Aged)						
R1 & R2	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	7		
R3	RESISTOR, 27K ±5%, 1/4W	616-02-27001	01121	RC07GF273J	1		
R4 & R5	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	3		
R7 & R8	RESISTOR, 220 Ohms ±5%, 1/4W	616-02-22009	01121	RC07GF221J	5		
R9	RESISTOR, 9.53K ±1%, 1/8W	605-09-95300	06141	625	2		
R10	RESISTOR, 3.3K ±10%, 1/2W	622-03-33000	01121	RC20GF332J	2		
R12	Same as R9						

Table 6-10 (Cont'd.). Detector Printed-Wiring Assembly (A2A11) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R13	Same as R10						
R14	RESISTOR, 1.5K ±10%, 1/2W	622-03-15000	01121	RC20GF152J	1		
R15	RESISTOR, 4.75K ±1%, 1/8W	605-09-47500	06141	625	1		
R16 & R17	Same as R7						
R18	RESISTOR, 820 Ohms ±5%, 1/4W	616-02-82009	01121	RC07GF821J	2		
R19	Same as R7						
R20	RESISTOR, 18K ±5%, 1/4W	616-02-18001	01121	RC07GF183J	1		
R22	RESISTOR, 301 Ohms ±1%, 1/8W	605-09-30109	06141	625	2		
R25	POTENTIOMETER, 5K ±30%, 1/2W	201-98-00093	73138	62PR5K	1		
R26	RESISTOR, 15K ±5%, 1/4W	616-02-15001	01121	RC07GF153J	1		
R27	Same as R18						
R28 thru R38	RESISTOR, Test Variable ±1%, 1/8W	605-09-00000	06141	625	11		
R40	RESISTOR, 1.0K ±1%, 1/8W	605-09-10000	06141	625	1		
R41 & R42	RESISTOR, 127 Ohms ±1%, 1/8W	605-09-12709	06141	625	2		
R43	Same as R22						
R44	Same as R1						
R45	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	7		
R46 & R47	RESISTOR, 100 Ohms ±5%, 1/4W	616-02-10009	01121	RC07GF101J	2		
R48	RESISTOR, 8.2K ±5%, 1/4W	616-02-82000	01121	RC07GF822J	3		
R49	Same as R4						
R50	Same as R45						
R51	Same as R1						
R52	RESISTOR, 22 Ohms ±5%, 1/4W	616-02-02209	01121	RC07GF220J	3		
R53	Same as R45						
R54	RESISTOR, 20K ±5%, 1/4W	616-02-20001	01121	RC07GF203J	1		
R55 & R56	Same as R45						
R57 & R58	RESISTOR, 7.87K ±1%, 1/8W	605-09-78700	06141	625	2		
R59 & R60	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	2		
R61	RESISTOR, 51 Ohms ±5%, 1/4W	616-02-05109	01121	RC07GF510J	1		
R62 & R63	POTENTIOMETER, 50 Ohms ±10%, 1W	201-98-00157	02660	2600P-50 BS1066	2		
R64	RESISTOR, 330 Ohms ±5%, 1/4W	616-02-33009	01121	RC07GF331J	1		

Table 6-10 (Cont'd.). Detector Printed-Wiring Assembly (A2A11) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R65	POTENTIOMETER, 200 Ohms ±10%, 1W	201-98-00029	02660	2600P-201 BS1066	1		
R66	RESISTOR, 510 Ohms ±5%, 1/4W	616-02-51009		RC07GF511J	1		
R67 & R68	POTENTIOMETER, 500 Ohms ±10%, 1W	201-98-00014	02660	2600P-501 BS1066	2		
R69	Same as R1						
R70	RESISTOR, 270 Ohms ±5%, 1/4W	616-02-27009	01121	RC07GF271J	2		
R71	Same as R52						
R73	Same as R70						
R74	Same as R52						
R75	RESISTOR, 2.05K ±1%, 1/8W	605-09-20500	06141	625	1		
R76	RESISTOR, 3.92K ±1%, 1/8W	605-09-39200	06141	625	1		
R77	RESISTOR, 1.3K ±5%, 1/4W	616-02-13000	01121	RC07GF132J	1		
R78	Same as R45						
R79	Same as R1						
R80	RESISTOR, Test Variable, ±1%, 1/8W	605-09-00000	06141	625	3		
R81	RESISTOR, 2.10K ±1%, 1/8W	605-09-21000	06141	625	1		
R82	RESISTOR, 2.21K ±1%, 1/8W	605-09-22100	06141	625	1		
R83	RESISTOR, 4.42K ±1%, 1/8W	605-09-44200	06141	625	1		
R84	RESISTOR, 8.87K ±1%, 1/8W	605-09-88700	06141	625	1		
R85	RESISTOR, 17.8K ±1%, 1/8W	605-09-17801	06141	625	1		
R86	Same as R48						
R87	RESISTOR, 47 Ohms ±5%, 1/4W	616-02-04709	01121	RC07GF470J	2		
R88	Same as R45						
R89	Same as R87						
R90	Same as R48						
R92 & R93	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	11		
R94	RESISTOR, 75K ±5%, 1/4W	616-02-75001	01121	RC07GF753J	1		
R95 thru R99	RESISTOR, 100K ±5%, 1/4W	616-02-10002	01121	RC07GF104J	5		

Table 6-10 (Cont'd.). Detector Printed-Wiring Assembly (A2A11) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R100 thru R104	Same as R92						
R105 & R106	RESISTOR, 30K ±5%, 1/4W	616-02-30001	01121	RC07GF303J	4		
R107	RESISTOR, 200 Ohms ±5%, 1/4W	616-02-20009	01121	RC07GF201J	2		

Table 6-10 (Cont'd.). Detector Printed-Wiring Assembly (A2A11) Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R108 & R109	Same as R92						
R110	Same as R1						
R111 & R112	Same as R92						
R113	Same as R105						
R114	Same as R107						
R115	Same as R105						
R116	RESISTOR, 3.9K ±5%, 1/4W	616-02-39000	01121	RC07GF392J	1		
R117	Same as R80						
Z1	INTEGRATED CIRCUIT	046-16-00013	04713	MC1710CP	1		
Z2	INTEGRATED CIRCUIT (Aged)	046-34-00001	12040	LM201	1		
Z3	INTEGRATED CIRCUIT (Aged)	046-18-00012	07263	U5J772632X	1		

Table 6-11. Single Pole Printed-Wiring Assembly (A2A12)
Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	SINGLE POLE PRINTED-WIRING ASSEMBLY	205-89-00684	06141	17165	1		
C1	CAPACITOR, .238 Mf ±2%, 50V	371-02-23802	07994	EM-MPABPC	1		
C2	CAPACITOR, .0214 Mf ±2%, 50V	371-02-21401	07994	EM-MPABPC	1		
C3	CAPACITOR, 2360 Pf ±1%, 500V	305-20-23600	06141	600	1		
C4	CAPACITOR, 1.05 Mf ±2%, 50V	372-02-10503	13934	7XF	1		
C5	CAPACITOR, .095 Mf ±2%, 50V	371-02-95001	07994	EM-MPABPC	1		
C6	CAPACITOR, .0103 Mf ±2%, 50V	371-02-10301	07994	EM-MPABPC	1		
C7	CAPACITOR, 1000 Pf ±1%, 500V	305-20-10000	06141	600	1		
C8	CAPACITOR, 76 Pf ±1%, 500V	304-13-07609	06141	600	1		
C9	CAPACITOR, 964 Pf ±1%, 500V	305-20-96409	06141	600	1		
C10	CAPACITOR, 52 Pf ±1%, 500V	304-13-05209	06141	600	1		
C13	CAPACITOR, 47 Mf ±20%, 35V	339-23-47004	06141	601	1		
C14	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	4		
C15 & C16	CAPACITOR, .1 Mf +80%-20%, 50V	301-14-10002	72982	8131-050-651-104Z	5		
C17	CAPACITOR, 4.7 Mf ±20%, 35V	337-23-47003	06141	601	2		
C18	Same as C15						
C19	CAPACITOR, 6.8 Mf ±20%, 35V	337-23-68003	06141	601	2		
C20	CAPACITOR, 750 Pf ±1%, 300V	304-41-75009	06141	600	1		
C21	Same as C15						
C22	Same as C17						
C23	Same as C15						
C24	Same as C14						
C27	Same as C19						
C28 & C29	Same as C14						
C30	CAPACITOR, 18 Pf ±.5 Pf, 500V	304-01-01809	06141	600	1		
C31	CAPACITOR, 36 Pf ±.5 Pf, 500V	304-08-03609	06141	600	1		
CR1 thru CR39	DIODE	088-10-41480	JEDEC	1N4148	39		
K1 thru K8	RELAY, 1 Form A Contact, .125 Ma	219-98-00065	27682	65630-15/GP-1A-26D	10		

Table 6-11 (Cont'd.). Single Pole Printed-Wiring Assembly (A2A12) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
K9 thru K12	RELAY, Spdt, NO, 26V	219-98-00051	27682	GP-1C-26-FCD	4		
K13	Same as K1						
K14 thru K16	RELAY, 2 Form A Contacts	219-98-00045	27682	GP-2A-26-P	4		
K17	Same as K1						
K18	Same as K14						
L1	INDUCTOR ASSY.	055-89-00001	06141	956-1306	1		
Q1	TRANSISTOR	263-99-00089	06141	666	1		
Q2 thru Q8	TRANSISTOR	263-10-39470	JEDEC	2N3947	8		
Q9	TRANSISTOR	263-10-36460	JEDEC	2N3646	1		
Q10	Same as Q2						
R1	RESISTOR, 1.00 Meg Ohms ±1%, 1/8W	607-01-10003	01121	RN60D1004F	1		
R2	RESISTOR, 499K ±1%, 1/8W	605-09-49902	06141	625	1		
R3	RESISTOR, 249K ±1%, 1/8W	605-09-24902	06141	625	1		
R4	RESISTOR, 124K ±1%, 1/8W	605-09-12402	06141	625	1		
R5	RESISTOR, 100K ±1%, 1/8W	605-09-10002	06141	625	1		
R6	RESISTOR, 49.9K ±1%, 1/8W	605-09-49901	06141	625	1		
R7	RESISTOR, 24.9K ±1%, 1/8W	605-09-24901	06141	625	1		
R8	RESISTOR, 12.4K ±1%, 1/8W	605-09-12401	06141	625	1		
R9	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	2		
R10	RESISTOR, 4.99K ±1%, 1/8W	605-09-49900	06141	625	2		
R11	RESISTOR, 2.49K ±1%, 1/8W	605-09-24900	06141	625	2		
R12	RESISTOR, 1.24K ±1%, 1/2W	604-02-12400	01121	RN70C1241F	2		
R13	POTENTIOMETER, 20K ±10%, .75W PC Mtg	201-98-00105	73138	79PR20K	1		
R14	RESISTOR, 18.7K ±1%, 1/8W	605-09-18701	06141	625	1		
R15	RESISTOR, 4.7 Meg Ohms ±5%, 1/4W	616-02-47003	01121	RC07GF475J	1		
R16	RESISTOR, 1K ±1%, 1/8W	605-09-10000	06141	625	1		
R17 & R18	RESISTOR, 301K ±1%, 1/8W	605-09-30102	06141	625	2		
R19	POTENTIOMETER, 10K ± 10%, .75W	201-98-00148	73138	79PR10K	1		
R22	RESISTOR, 1.5K ±1%, 1/8W	605-09-15000	06141	625	1		
R23 & R24	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	4		

Table 6-11 (Cont'd.). Single Pole Printed-Wiring Assembly (A2A12) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R25	RESISTOR, 1.5K ±5%, 1/4W	616-02-15000	01121	RC07GF152J	2		
R26	RESISTOR, 47 Ohms ±5%, 1/4W	616-02-04709	01121	RC07GF470J	2		
R27	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	3		
R28	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	2		
R29	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	2		
R30	RESISTOR, 51 Ohms ±5%, 1/4W	616-02-05109	01121	RC07GF510J	1		
R31	RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	01121	RC07GF222J	4		
R32	RESISTOR, 470 Ohms ±5%, 1/4W	616-02-47009	01121	RC07GF471J	1		
R33	Same as R23						
R34	RESISTOR, 511 Ohms ±1%, 1/8W	605-09-51109	06141	625	1		
R35	RESISTOR, 9.09K ±1%, 1/8W	605-09-90900	06141	625	1		
R36	Same as R27						
R37	Same as R26						
R38	RESISTOR, 120K ±5%, 1/4W	616-02-12002	01121	RC07GF124J	1		
R39 & R40	RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	01121	RC07GF472J	4		
R41	POTENTIOMETER, 10K, ±30%, 1/2W	201-98-00149	73138	62PR10K	1		
R42	Same as R25						
R43	Same as R29						
R44	Same as R31						
R45	POTENTIOMETER, 10K ±10%, .75W PC Mtg	201-98-00148	73138	79PR10K	1		
R46 & R47	Same as R39						
R48	RESISTOR, 453 Ohms ±1%, 1/8W	605-09-45309	06141	625	1		
R49	RESISTOR, 6.8K ±5%, 1/4W	616-02-68000	01121	RC07GF682J	1		
R51	Same as R23						
R52	Same as R31						
R53	RESISTOR, 4.02K ±1%, 1/8W	605-09-40200	06141	625	1		
R54	Same as R31						
R55	RESISTOR, 510 Ohms ±5%, 1/4W	616-02-51009	01121	RC07GF511J	1		
R56	RESISTOR, 3.9K ±5%, 1/4W	616-02-39000	01121	RC07GF392J	1		
R57	RESISTOR, 18K ±5%, 1/4W	616-02-18001	01121	RC07GF183J	1		
R58	Same as R28						
R59	Same as R9						
R60	Same as R10						

Table 6-11 (Cont'd.). Single Pole Printed-Wiring Assembly (A2A12) Parts List (Rev. H)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R61	Same as R11						
R62	Same as R12						
R64	Same as R27						
R65	RESISTOR, 20K ±5%, 1/4W	616-02-20001	01121	RC07GF203J	1		
TP1 thru TP3	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	3		
Z1 & Z2	PWA, Amplifier	205-89-01735	06141	30471	2		

Table 6-12. Pole Pair Printed-Wiring Assembly (A2A13)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	POLE PAIR PRINTED-WIRING ASSEMBLY	205-89-00672	06141	15152-2	1		
C1 & C2	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	3		
C3	CAPACITOR, .460 Mf ±2%, 50V	371-02-46002	07994	EM-MPABPC	1		
C4	CAPACITOR, .160 Mf ±2%, 50V	371-02-16002	07994	EM-MPABPC	1		
C5	CAPACITOR, .0419 Mf ±2%, 50V	371-02-41901	07994	EM-MPABPC	1		
C6	CAPACITOR, .0148 Mf ±2%, 50V	371-02-14801	07994	EM-MPABPC	1		
C7	CAPACITOR, 1600 Pf ±1%, 500V	305-20-16000	06141	600	1		
C8	CAPACITOR, 4660 Pf ±1%, 500V	305-20-46600	06141	600	1		
C9	CAPACITOR, 560 Pf ±1%, 300V	304-41-56009	06141	600	1		
C10	CAPACITOR, 33 Pf ±.5 Pf, 500V	304-08-03309	06141	600	1		
C11	CAPACITOR, 27 Pf ±.5 Pf, 500V	304-08-02709	06141	600	1		
C12	CAPACITOR, 426 Pf ±1%, 500V	304-20-42609	06141	600	1		
C13	CAPACITOR, 2100 Pf ±1%, 500V	305-20-21000	06141	600	1		
C14	CAPACITOR, 132 Pf ±1%, 500V	304-20-13209	06141	600	1		
C15	CAPACITOR, 160 Pf ±1%, 500V	304-20-16009	06141	600	1		
C16	CAPACITOR, 2460 Pf ±1%, 500V	305-20-24600	06141	600	1		
C17	CAPACITOR, .0225 Mf ±2%, 50V	371-02-22501	07994	EM-MPABPC	1		
C18	CAPACITOR, 4300 Pf ±1%, 500V	305-20-43000	06141	600	1		
C19	CAPACITOR, .0397 Mf ±2%, 50V	371-02-39701	07994	EM-MPABPC	1		
C20	CAPACITOR, .204 Mf ±2%, 50V	371-02-20402	07994	EM-MPABPC	1		
C21	CAPACITOR, .433 Mf ±2%, 50V	371-02-43302	07994	EM-MPABPC	1		
C22	CAPACITOR, 2.23 Mf ±2%, 50V	372-02-22303	13934	7XF	1		
C25	CAPACITOR, 36 Pf ±.5 Pf, 500V	304-08-03609	06141	600	2		
C28	Same as C25						
C29	Same as C1						
CR1 thru CR3	DIODE	088-10-41480	JEDEC	1N4148	3		
K1 thru K11	RELAY, 2 Form A Contacts	219-98-00066	27682	65630-16/GP-2A-26D	11		
K12 thru K14	RELAY, 2 Form A Contacts	219-98-00045	27682	GP-2A-26P	5		

Table 6-12 (Cont'd.). Pole Pair Printed-Wiring Assembly (A2A13)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
K15 thru K17	RELAY, 4 PST, NO, 26V	219-98-00050	27682	GP-4A-26P	3		
K18 & K19	Same as K12						
Q1 & Q2	TRANSISTOR	263-99-00089	06141	666	2		
R1	RESISTOR, 1.00 Meg Ohm ±1%, 1/8W	607-01-10003	01121	RN60D1004F	2		
R2	RESISTOR, 499K ±1%, 1/8W	605-09-49902	06141	625	2		
R3	RESISTOR, 249K ±1%, 1/8W	605-09-24902	06141	625	2		
R4	RESISTOR, 124K ±1%, 1/8W	605-09-12402	06141	625	2		
R5	RESISTOR, 100K ±1%, 1/8W	605-09-10002	06141	625	2		
R6	RESISTOR, 49.9K ±1%, 1/8W	605-09-49901	06141	625	2		
R7	RESISTOR, 24.9K ±1%, 1/8W	605-09-24901	06141	625	2		
R8	RESISTOR, 12.4K ±1%, 1/8W	605-09-12401	06141	625	2		
R9	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	2		
R10	RESISTOR, 4.99K ±1%, 1/8W	605-09-49900	06141	625	2		
R11	RESISTOR, 2.49K ±1%, 1/8W	605-09-24900	06141	625	2		
R12	RESISTOR, 1.24K ±1%, 1/8W	605-09-12400	06141	625	2		
R13 & R14	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	3		
R15	POTENTIOMETER, 20K ±10%, .75W PC Mtg.	201-98-00105	73138	79PR20K	2		
R16	Same as R1						
R17	Same as R2						
R18	Same as R3						
R19	Same as R4						
R20	Same as R5						
R21	Same as R6						
R22	Same as R7						
R23	Same as R8						
R24	Same as R9						
R25	Same as R10						
R26	Same as R11						
R27	Same as R12						
R28	RESISTOR, 18.7K ±1%, 1/8W	605-09-18701	06141	625	2		
R29	RESISTOR, 4.7 Meg Ohms ±5%, 1/4W	616-02-47003	01121	RC07GF475J	2		
R30 & R31	RESISTOR, 301K ±1%, 1/8W	605-09-30102	06141	625	4		

Table 6-12 (Cont'd.). Pole Pair Printed-Wiring Assembly (A2A13)
Parts List (Rev. C)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R32	RESISTOR, 1K ±1%, 1/8W	605-09-10000	06141	625	2		
R33	POTENTIOMETER, 100 Ohms ±10%, .75W PC Mtg.	201-98-00145	73138	79PR100	2		
R35	RESISTOR, 33 Ohms ±5%, 1/4W	616-02-03309	01121	RC07GF330J	2		
R36	RESISTOR, 422 Ohms ±1%, 1/8W	605-09-42209	06141	625	1		
R37	Same as R15						
R38	Same as R29						
R39	Same as R28						
R40	Same as R32						
R41 & R42	Same as R30						
R43	Same as R33						
R45	Same as R35						
R46	RESISTOR, 412 Ohms ±1%, 1/8W	605-09-41209	06141	625	1		
R47	Same as R13						
R49 thru R52	RESISTOR, 10Ω ±5%, 1/4W	616-02-01009	01121	RC07GF100J	4		
TP1 thru TP4	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	4		
Z1 & Z2	INTEGRATED CIRCUIT	046-89-00002	06141	5515	2		

Table 6-13. Pole Pair Printed-Wiring Assembly (A2A14)
Parts List (Rev. A)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	POLE PAIR PRINTED-WIRING ASSEMBLY	205-89-00673	06141	15152-3	1		
C1 & C2	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	3		
C3	CAPACITOR, .531 Mf ±2%, 50V	372-02-53102	13934	7XF	1		
C4	CAPACITOR, .420 Mf ±20%, 50V	371-02-42002	07994	EM-MPABPC	1		
C5	CAPACITOR, .0482 Mf ±2%, 50V	371-02-48201	07994	EM-MPABPC	1		
C6	CAPACITOR, .0385 Mf ±2%, 50V	371-02-38501	07994	EM-MPABPC	1		
C7	CAPACITOR, 4060 Pf ±1%, 500V	305-20-40600	06141	600	1		
C8	CAPACITOR, 5350 Pf ±1%, 500V	306-20-53500	06141	600	1		
C9	CAPACITOR, 862 Pf ±1%, 500V	305-20-86209	06141	600	1		
C10	CAPACITOR, 91 Pf ±1%, 500V	304-20-09109	06141	600	1		
C11	CAPACITOR, 43 Pf ±.5 Pf, 500V	304-08-04309	06141	600	1		
C12	CAPACITOR, 480 Pf ±1%, 500V	304-20-48009	06141	600	1		
C13	CAPACITOR, 1350 Pf ±1%, 500V	305-20-13500	06141	600	1		
C14	CAPACITOR, 59 Pf ±1%, 500V	304-13-05909	06141	600	1		
C15	CAPACITOR, 82 Pf ±1%, 500V	304-13-08209	06141	600	1		
C16	CAPACITOR, 1590 Pf ±1%, 500V	305-20-15900	06141	600	1		
C17	CAPACITOR, .0151 Mf ±2%, 50V	371-02-15101	07994	EM-MPABPC	1		
C18	CAPACITOR, 2050 Pf ±1%, 500V	305-20-20500	06141	600	1		
C19	CAPACITOR, .0180 Mf ±2%, 50V	371-02-18001	07994	EM-MPABPC	1		
C20	CAPACITOR, .136 Mf ±2%, 50V	371-02-13602	07994	EM-MPABPC	1		
C21	CAPACITOR, .204 Mf ±2%, 50V	371-02-20402	07994	EM-MPABPC	1		
C22	CAPACITOR, 1.50 Mf ±2%, 50V	372-02-15003	13934	7XF	1		
C23	CAPACITOR, 2500 Pf ±1%, 500V	305-20-25000	06141	600	2		
C25	CAPACITOR, 36 Pf ±.5 Pf, 500V	304-08-03609	06141	600	2		
C26	Same as C23						
C28	Same as C25						
C29	Same as C1						
CR1 thru CR3	DIODE	088-10-41480	JEDEC	1N4148	3		
K1 thru K14	RELAY, 2 Form A Contact	219-98-00045	27682	GP-2A-26-P	16		
K15 thru K17	RELAY, 4 Pst, NO, 26V	219-98-00050	27682	GP-4A-26-P	3		

Table 6-13 (Cont'd.). Pole Pair Printed-Wiring Assembly (A2A14) Parts List (Rev. A)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
K18 & K19	Same as K1						
Q1 & Q2	TRANSISTOR	263-99-00089	06141	666	2		
R1	RESISTOR, 1.00 Meg Ohm ±1%, 1/8W	607-01-10003	01121	RN60D1004F	2		
R2	RESISTOR, 499K ±1%, 1/8W	605-09-49902	06141	625	2		
R3	RESISTOR, 249K ±1%, 1/8W	605-09-24902	06141	625	2		
R4	RESISTOR, 124K ±1%, 1/8W	605-09-12402	06141	625	2		
R5	RESISTOR, 100K ±1%, 1/8W	605-09-10002	06141	625	2		
R6	RESISTOR, 49.9K ±1%, 1/8W	605-09-49901	06141	625	2		
R7	RESISTOR, 24.9K ±1%, 1/8W	605-09-24901	06141	625	2		
R8	RESISTOR, 12.4K ±1%, 1/8W	605-09-12401	06141	625	2		
R9	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	2		
R10	RESISTOR, 4.99K ±1%, 1/8W	605-09-49900	06141	625	2		
R11	RESISTOR, 2.49K ±1%, 1/8W	605-09-24900	06141	625	2		
R12	RESISTOR, 1.24K ±1%, 1/8W	605-09-12400	06141	625	2		
R13 & R14	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	3		
R15	POTENTIOMETER, 20K ±10%, .75W PC Mtg	201-98-00105	73138	79PR20K	2		
R16	Same as R1						
R17	Same as R2						
R18	Same as R3						
R19	Same as R4						
R20	Same as R5						
R21	Same as R6						
R22	Same as R7						
R23	Same as R8						
R24	Same as R9						
R25	Same as R10						
R26	Same as R11						
R27	Same as R12						
R28	RESISTOR, 18.7K ±1%, 1/8W	605-09-18701	06141	625	2		
R29	RESISTOR, 4.7 Meg Ohms ±5%, 1/4W	616-02-47003	01121	RC07GF475J	2		
R30 & R31	RESISTOR, 301K ±1%, 1/8W	605-09-30102	06141	625	4		
R32	RESISTOR, 1K ±1%, 1/8W	605-09-10000	06141	625	2		
R33	POTENTIOMETER, 10K ± 10%, .75W PC Mtg	201-98-00148	73138	79PR10K	2		

Table 6-13 (Cont'd.). Pole Pair Printed-Wiring Assembly (A2A14) Parts List (Rev. A)

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R36	RESISTOR, 422 Ohms ±1%, 1/8W	605-09-42209	06141	625	1		
R37	Same as R15						
R38	Same as R29						
R39	Same as R28						
R40	Same as R32						
R41 & R42	Same as R30						
R43	Same as R33						
R46	RESISTOR, 412 Ohms ±1%, 1/8W	605-09-41209	06141	625	1		
R47	Same as R13						
R48	RESISTOR, 76.8K ±1%, 1/8W	605-09-76801	06141	625	1		
R49 thru R52	RESISTOR, 10Ω ±5%, 1/4W	616-02-01009	01121	RC07GF100J	4		
TP1 thru TP4	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	4		
Z1 & Z2	PWA, Amplifier	205-89-01735	06141	30471	2		

Table 6-14. Regulator/Output Amplifier Printed-Wiring Assembly (A2A15) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
	REGULATOR/OUTPUT AMPLIFIER PRINTED-WIRING ASSEMBLY	205-89-00674	06141	14823-1 (Rev. F)	1		
C1	CAPACITOR, .1 Mf +80% -20%, 50V	301-14-10002	72982	8131-050-651-104Z	5		
C2	CAPACITOR, 47 Mf ±20%, 35V	339-23-47004	06141	601	5		
C3	CAPACITOR, 3.3 Mf ±20%, 35V	337-23-33003	06141	601	2		
C5	CAPACITOR, 6.8 Mf ±20%, 35V	337-23-68003	06141	601	1		
C6	CAPACITOR, 20 Pf ±.5 Pf, 500V	304-01-02009	06141	600	1		
C7	CAPACITOR, .01 Mf ±20%, 50V	301-03-10001	72982	8121-050-651-103M	1		
C8	Same as C3						
C9	Same as C1						
C10	Same as C2						
C11	Same as C1						
C12	Same as C2						
C13	CAPACITOR, .10 Mf ±10%, 35V	336-14-10002	06141	601	1		
C14	Same as C1						
C15	Same as C2						
C16	Same as C1						
C17	Same as C2						
C18	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	1		
C19	CAPACITOR, 4.7 Mf ±20%, 10V	336-20-47003	06141	601	1		
CR1, 2 & 3	DIODE	088-10-41480	JEDEC	1N4148	11		
CR4	DIODE	088-99-00099	06141	642-00	2		
CR5	DIODE	088-10-40020	JEDEC	1N4002	5		
CR6 thru CR11	Same as CR1						
CR12	DIODE, 9.0V, Ref Diode	088-10-09360	JEDEC	1N936	1		
CR13	Same as CR4						
CR14 thru CR17	Same as CR5						
CR18 & 19	Same as CR1						
F1, 2, & 4	FUSE, 1 Amp, 250V	120-98-00012	75915	312001	3		
F3 & 5	FUSE, Fast-Blo, 1-1/2 Amp	120-98-00033	75915	31201.5	2		

Table 6-14 (Cont'd.). Regulator/Output Amplifier Printed-Wiring Assembly (A2A15) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
K1	RELAY, 1 Form A Contacts	219-98-00051	27682	GP-1C-26-FCD	1		
K2	RELAY, 2 Form C Contacts	219-98-00046	27682	GP-2C-26-FCD	1		
Q1	TRANSISTOR	263-10-37400	JEDEC	2N3740	4		
Q2	TRANSISTOR, NPN, Dual Ampl.	263-16-00179	04713	MD8001	3		
Q3	TRANSISTOR	263-10-39470	JEDEC	2N3947	5		
Q4	TRANSISTOR	263-99-00139	06141	805-1	6		
Q5	Same as Q3						
Q6	TRANSISTOR	263-10-30530	JEDEC	2N3053	1		
Q7	Same as Q1						
Q8	Same as Q3						
Q9	Same as Q2						
Q10	TRANSISTOR	263-10-40370	JEDEC	2N4037	1		
Q11	TRANSISTOR	263-10-37660	JEDEC	2N3766	3		
Q12	Same as Q4						
Q13	Same as Q11						
Q14	Same as Q1						
Q15 & Q16	Same as Q4						
Q17	Same as Q2						
Q18	Same as Q11						
Q19	Same as Q1						
Q20 & Q21	Same as Q4						
Q22 & Q23	Same as Q3						
R1	RESISTOR, 1.3K ±5%, 1/4W	616-02-13000	01121	RC07GF132J	3		
R2	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	4		
R3	RESISTOR, 3.01K ±1%, 1/8W	605-09-30100	06141	625	2		
R4	RESISTOR, 2.0K ±1%, 1/8W	605-09-20000	06141	625	1		
R5	RESISTOR, 100 Ohms ±5%, 1/4W	616-02-10009	01121	RC07GF101J	4		
R6	RESISTOR, 549 Ohms ±1%, 1/8W	605-09-54909	06141	625	3		
R7	RESISTOR, 470 Ohms ±5%, 1/4W	616-02-47009	01121	RC07GF471J	6		
R8	RESISTOR, 22 Ohms ±5%, 1/4W	616-02-02209	01121	RC07GF220J	2		
R9	RESISTOR, 750 Ohms ±5%, 1/4W	616-02-75009	01121	RC07GF751J	2		

Table 6-14 (Cont'd.). Regulator/Output Amplifier Printed-Wiring Assembly (A2A15) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R10	Same as R2						
R11	RESISTOR, 1.5K ±5%, 1/4W	616-02-15000	01121	RC07GF152J	2		
R12	RESISTOR, 1.6K ±5%, 1/4W	616-02-16000	01121	RC07GF162J	2		
R13	RESISTOR, 3 K ±5%, 1/4W	616-02-30000	01121	RC07GF302J	1		
R14	RESISTOR, 330 Ohms ±5%, 1/4W	616-02-33009	01121	RC07GF331J	5		
R15	Same as R7						
R16	RESISTOR, 2.0K ±1%, 1/8W	605-09-20000	06141	625	2		
R17	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	5		
R18	Same as R5						
R19	RESISTOR, 300 Ohms ±5%, 1/4W	616-02-30009	01121	RC07GF301J	1		
R20	Same as R2						
R21	RESISTOR, 12 Ohms ±5%, 1/4W	616-02-01209	01121	RC07GF120J	1		
R22	POTENTIOMETER, 5K ±10%, .75W PC Mtg	201-98-00147	73138	79PR5K	1		
R23	Same as R1						
R24	POTENTIOMETER, 500 Ohms ±10%, .75W PC Mtg	201-98-00122	73138	79PR500	3		
R25	POTENTIOMETER, 50 Ohms ±10%, .75W PC Mtg	201-98-00121	73138	79PR50	1		
R26	RESISTOR, 15.4K ±1%, 1/8W	605-09-15401	06141	625	1		
R27	Same as R9						
R28	Same as R12						
R29 & R30	Same as R17						
R31	Same as R16						
R32	RESISTOR, 4.53K ±1%, 1/8W	605-09-45300	06141	625	3		
R33	RESISTOR, 12.1K ±1%, 1/8W	605-09-12101	06141	625	1		
R34	RESISTOR, 1.5K ±1%, 1/8W	605-09-15000	06141	625	1		
R35 & R36	Same as R6						
R37	Same as R7						
R38	Same as R11						
R41	Same as R2						
R42	Same as R17						
R43	Same as R8						
R45	RESISTOR, Test Variable, ±5%, 1/4W	616-02-00000	06141		2		

Table 6-14 (Cont'd.). Regulator/Output Amplifier Printed-Wiring Assembly (A2A15) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R46	Same as R14						
R47	Same as R7						
R48	Same as R32						
R49	Same as R5						
R50	RESISTOR, 316 Ohms ±1%, 1/8W	605-09-31609	06141	625	2		
R51	Same as R1						
R52	Same as R14						
R53	Same as R24						
R54	RESISTOR, 200 Ohms ±5%, 1/4W	616-02-20009	01121	RC07GF201J	2		
R55	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	1		
R56	Same as R32						
R57	RESISTOR, 3.83K ±1%, 1/8W	605-09-38300	06141	625	2		
R58	POTENTIOMETER, 100 Ohms ±10%, .75W PC Mtg	201-98-00145	73138	79PR100	2		
R59	RESISTOR, 866 Ohms ±1%, 1/8W	605-09-86609	06141	625	2		
R60	Same as R7						
R61	RESISTOR, 590 Ohms ±1%, 1/8W	605-09-59009	06141	625	2		
R62	Same as R57						
R63	Same as R5						
R64	Same as R50						
R67	RESISTOR, 120 Ohms ±5%, 1/4W	616-02-12009	01121	RC07GF121J	1		
R68	RESISTOR, 2.74K ±1%, 1/8W	605-09-27400	06141	625	1		
R69 & R70	Same as R14						
R71	Same as R59						
R72	Same as R7						
R73	Same as R58						
R74	RESISTOR, 360 Ohms ±5%, 1/4W	616-02-36009	01121	RC07GF361J	1		
R75	Same as R61						
R76 & R77	RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	06141	625	2		
R78	Same as R17						
R79	RESISTOR, 2.26K ±1%, 1/8W	605-09-22600	06141	625	1		
R80	Same as R45						
R81	Same as R54						

Table 6-14 (Cont'd.). Regulator/Output Amplifier Printed-Wiring Assembly (A2A15) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R82	RESISTOR, 5.76K ±1%, 1/8W	605-09-57600	06141	625	1		
R83	Same as R24						
R84	Same as R3						
TP1 thru TP9	JACK, Test Point, Red	143-98-00017	00779	3-582340-2	9		

Table 6-15. Power Supply Assembly (A4) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
A4	POWER SUPPLY ASSEMBLY (Rev. A)	202-89-00028	06141	14976-2	1		
A4A1	OVEN ASSY. (Rev. A)	187-89-00004	06141	14981	1		
	ELEMENT, Heater Strip, 25W, 24V	103-98-00001	*	107445	1		
	CONNECTOR, Plug, 15 Pin, R & P	063-98-00059	71468	DA-15P	1		
RT1	THERMISTOR, 30K@25°C	413-98-00008	97794	44008	1		
	VCO & TEMPERATURE REGULATOR (Oven Card A) (Rev. F)	205-89-00410	06141	14128	1		
C1	CAPACITOR, .1 Mf +80% -20%, 50V	301-14-10002	72982	8131-050-651-104Z	4		
C2 & C3	CAPACITOR, Test Variable	304-20-00000	06141	600	2		
C4 & C5	Same as C1						
C6	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	1		
C7	Same as C1						
CR1	DIODE	088-10-07480	JEDEC	1N748	1		
CR2	IC, Diode Array, 6 ISOL	046-15-00007	02735	CA3039	1		
L1 & L2	INDUCTOR ASSY.	055-89-00001	06141	956-1306	2		
Q1	TRANSISTOR, Diff Amp., Dual (Aged)	263-16-00129	04713	MD3251	2		
Q2 & Q3	TRANSISTOR	263-99-00139	06141	805-1	3		
Q4	Same as Q1 (Aged)						
Q5 & Q6	TRANSISTOR, SW-Amp., 40V 1A, 30W	263-10-49210	JEDEC	2N4921	2		
Q7	TRANSISTOR	263-10-39470	JEDEC	2N3947	3		
Q8	Same as Q2						
Q9 & Q10	Same as Q7						
Q11, Q12, Q13	TRANSISTOR, NPN 20V Sw. 350 MHz/ 10 mA/20V to -18	263-99-00099	06141	801	1		
R1	RESISTOR, 4.64K ±1%, 1/10W	608-09-46400	06141	624	4		
R2 & R3	RESISTOR, Test Variable	608-09-00000	06141	624	3		
R4	RESISTOR, Test Variable	608-09-00000	06141	624	3		
R5	Same as R2						
R6	Same as R1						
R7 & R8	RESISTOR, 100.0 Ohms ±1%, 1/10W	608-09-10009	06141	624	2		
R9	RESISTOR, 59.0K ±1%, 1/10W	608-09-59001	06141	624	1		
R10	RESISTOR, 8.2K ±5%, 1/4W	616-02-82000	01121	RC07GF822J	1		
R11	RESISTOR, 10K ±5%, 1/4W	616-02-10001	01121	RC07GF103J	3		
R12	RESISTOR, 2.4K ±5%, 1/4W	616-02-24000	01121	RC07GF242J	1		
R13	Same as R1						

*Electrofilm, Inc., North Hollywood, Calif.

Table 6-15 (Cont'd.). Power Supply Assembly (A4) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R14 & R15	RESISTOR, 5.11K ±1%, 1/10W	608-09-51100	06141	624	2		
R16	Same as R1						
R17	RESISTOR, 3.9K ±5%, 1/4W	616-02-39000	01121	RC07GF392J	1		
R18	RESISTOR, 8.06K ±1%, 1/10W	608-09-80600	06141	624	1		
R19	RESISTOR, 6.49K ±1%, 1/10W	608-09-64900	06141	624	1		
R20 & R21	Same as R4						
R22 & R23	RESISTOR, 3.16K ±1%, 1/10W	608-09-31600	06141	624	2		
R24	RESISTOR, 909.0 Ohms ±1%, 1/10W	608-09-90909	06141	624	1		
R25	RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	01121	RC07GF100J	1		
R26	RESISTOR, 10K ±1%, 1/10W	608-09-10001	06141	624	2		
R27 & R28	RESISTOR, 8.25K ±1%, 1/10W	608-09-82500	06141	624	2		
R29	Same as R26						
R30	RESISTOR, 100 Ohms ±5%, 1/4W	616-02-10009	01121	RC07GF101J	1		
R31	RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	01121	RC07GF182J	1		
R32	RESISTOR, 4.53K ±1%, 1/10W	608-09-45300	06141	624	1		
R33	RESISTOR, 4.02K ±1%, 1/10W	608-09-40200	06141	624	1		
R34 & R35	Same as R11						
R36 & R37	RESISTOR, 1 Ohm ±10%, 1/2W	622-03-00109	01121	EB10G1	2		
R38	RESISTOR, 1K ±5%, 1/4W	616-02-10000	01121	RC07GF102J	1		
S1	SWITCH, Thermal, Open 185 Close	250-98-00142	01295	3BTL8	1		
T1	TRANSFORMER	262-89-00008	06141	6562-2	1		
Z1	INTEGRATED CIRCUIT (Aged)	046-89-00005	06141	5840	1		
	CRYSTAL OSCILLATOR & REFERENCE REGULATOR (Oven Card B)	205-89-00411	06141	14129	1		
C1	CAPACITOR, 15 Pf ±.5 Pf, 500V	304-01-01509	06141	600	1		
C2 thru C6	CAPACITOR, .1 Mf +80% −20%, 50V	301-14-10002	72982	8131-050-651-104Z	5		
C7	CAPACITOR, Trimmer, 5.5 - 18 Pf	320-98-00008	72982	538-007-92A	1		
C8	CAPACITOR, 100 Pf ±1%, 500V	304-20-10009	06141	600	2		
C9	CAPACITOR, 4.7 Mf ±20%, 35V	337-23-47003	06141	601	2		
C10	Same as C8						
C11	Same as C9						

Table 6-15 (Cont'd.). Power Supply Assembly (A4) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
C12 & C13	CAPACITOR, 1.0 Mf ±20%, 35V	336-23-10003	06141	601	2		
CR1 & CR2	DIODE	088-10-41480	JEDEC	1N4148	4		
CR3	DIODE, 9.0V Ref. Diode	088-10-09360	JEDEC	1N936	1		

Table 6-15 (Cont'd.). Power Supply Assembly (A4) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
CR4 & CR5	Same as CR1						
L1	* INDUCTOR, 4.70 µh, 45Ω Min.	055-98-00054	99800	1025-36	1		
L2 & L3	INDUCTOR ASSY.	055-89-00001	06141	956-1306	2		
Q1 thru Q3	TRANSISTOR	263-10-39470	JEDEC	2N3947	7		
Q4	TRANSISTOR, SW-AMP, 40V 1A 30W	263-10-49210	JEDEC	2N4921	1		
Q5	TRANSISTOR	263-99-00139	06141	805-1	4		
Q6 thru Q8	Same as Q1						
Q9 thru Q11	Same as Q5						
Q12	TRANSISTOR, SW-AMP, 40V 1A 30W	263-10-49180	JEDEC	2N4918	1		
Q13	Same as Q1						
R1	RESISTOR, 680 Ohms ±5%, 1/4W	616-02-68009	01121	RC07GF681J	1		
R2	RESISTOR, 47 Ohms ±5%, 1/4W	616-02-04709	01121	RC07GF470J	3		
R3	RESISTOR, 12K ±5%, 1/4W	616-02-12001	01121	RC07GF123J	4		
R4	Same as R2						
R5	RESISTOR, 750 Ohms ±5%, 1/4W	616-02-75009	01121	RC07GF751J	3		
R6	Same as R3						
R7	Same as R2						
R8	RESISTOR, 51 Ohms ±5%, 1/4W	616-02-05109	01121	RC07GF510J	1		
R9 & R10	RESISTOR, 150 Ohms ±5%, 1/4W	616-02-15009	01121	RC07GF151J	2		
R11	RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	01121	RC07GF472J	2		
R12	RESISTOR, 510 Ohms ±5%, 1/4W	616-02-51009	01121	RC07GF511J	1		
R13	Same as R11						
R14	Same as R5						
R15	RESISTOR, 750.0 Ohms ±1%, 1/10W	608-09-75009	06141	624	2		
R16	RESISTOR, 12.1K ±1%, 1/10W	608-09-12101	06141	624	2		
R17	Same as R3						
R18	POTENTIOMETER, 500 Ohms ±10%, 1W	201-98-00014	02660	2600P-501 BS1066	1		
R19	Same as R3						
R20	RESISTOR, 4.22K ±1%, 1/10W	608-09-42200	06141	624	1		
R21	RESISTOR, 8.45K ±1%, 1/10W	608-09-84500	06141	624	1		

* May be changed in test to 3.9 µh or 5.6 µh.

Table 6-15 (Cont'd.). Power Supply Assembly (A4) Parts List

REF. DESIG.	DESCRIPTION	EMR STOCK NO.	MFGR. CODE	MFGR. PART NO.	TQ	RS	UNIT PRICE
R22	POTENTIOMETER, 1K ±10%, 1W	201-98-00015	02660	2600P-102 BS1066	1		
R23	Same as R15						
R24	RESISTOR, 620 Ohms ±5%, 1/4W	616-02-62009	01121	RC07GF621J	1		
R25	RESISTOR, 2.49K ±1%, 1/10W	608-09-24900	06141	624	1		
R26	RESISTOR, 5.62K ±1%, 1/10W	608-09-56200	06141	624	1		
R27	Same As R16						
Y1	CRYSTAL, 12.8 MHz	076-99-00272	06141	15681	1		
C1	CAPACITOR, 3600 Mf -10% +75%, 40V	353-90-36006	56289	36D362G015 AB2B	1		
C2	CAPACITOR, 8400 Mf -10% +75%, 40V	353-91-84006	56289	36D842G040 BB2B	2		
C3	CAPACITOR, 4600 Mf -10% +75%, 15V	353-88-46006	56289	36D462G015 AA2B	1		
C4	CAPACITOR, 9200 Mf -10% +75%, 15V	353-89-92006	56289	36D922G015 AB2B	1		
C5	Same As C2						
CR1 thru CR3	RECTIFIER	214-98-00001	04713	MDA952-2	3		
J1	CONNECTOR, Recp., 15 Pin, R & P	063-98-00069	71468	DA-155	1		
Q1	TRANSISTOR	263-16-00109	04713	MJ480	3		
Q2	TRANSISTOR	263-16-00119	04713	MJ490	2		
Q3	Same As Q1						
Q4	Same As Q2						
Q5	Same As Q1						
T1	TRANSFORMER, Power (4145)	262-99-00088	06141	13396-1	1		
T1	TRANSFORMER, Power (4145-01-8)	262-99-00089	06141	13396-2	1		

Table 6-16. Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
PRINTED-WIRING ASSEMBLY, Oven Card	205-89-00410	EMR	14128	1	1	
PRINTED-WIRING ASSEMBLY, Crystal Oscillator and Reference Regulator	205-89-00411	EMR	14129	1	1	
INTEGRATED CIRCUIT, Amplifier	046-89-00002	EMR	5515	9	2	
INTEGRATED CIRCUIT, Oscillator/ Detector	046-89-00005	EMR	5840	1	1	
INTEGRATED CIRCUIT, Assy., Follower, NPN	046-89-00009	EMR	12181	21	3	
INTEGRATED CIRCUIT, Assy., Follower, PNP	046-89-00010	EMR	12182	17	3	
LIGHT, Assy., Decimal	155-89-00001	EMR	7327	4	1	
PRINTED-WIRING ASSEMBLY, Binary Counter	205-89-00408	EMR	14098	1	1	
PRINTED-WIRING ASSEMBLY, Delay Line and Low Pass	205-89-00409	EMR	14101	1	1	
PRINTED-WIRING ASSEMBLY, BCD Converter	205-89-00413	EMR	14827	1	1	
PRINTED-WIRING ASSEMBLY, First I.F.	205-89-00414	EMR	15146	1	1	
PRINTED-WIRING ASSEMBLY, Second I.F.	205-89-00420	EMR	15161	1	1	
PRINTED-WIRING ASSEMBLY, Harmonic Selector	205-89-00422	EMR	15167	1	1	
PRINTED-WIRING ASSEMBLY, Extender Card	205-89-00501	EMR	14199	1	1	
PRINTED-WIRING ASSEMBLY, Pole Pair	205-89-00672	EMR	15152-2	1	1	
PRINTED-WIRING ASSEMBLY, Pole Pair	205-89-00673	EMR	15152-3	1	1	
PRINTED-WIRING ASSEMBLY, Regulator and Output Amplifier	205-89-00674	EMR	14823-1	1	1	
PRINTED-WIRING ASSEMBLY, Input Level Adjust	205-89-00675	EMR	15155-1	1	1	

Table 6-16 (Cont'd.). Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
PRINTED-WIRING ASSEMBLY, VCO and Harmonic Mixer	205-89-00682	EMR	17162	1	1	
PRINTED-WIRING ASSEMBLY, Detector	205-89-00683	EMR	17168	1	1	
PRINTED-WIRING ASSEMBLY, Single Pole	205-89-00684	EMR	17165	1	1	
FILTER, 4PP, 16 KHz, 6.25%	475-01-00001	EMR	13754	1	1	
FILTER, 4PP, 32 KHz, 6.25%	475-01-00002	EMR	13754	1	1	
FILTER, 4PP, 64 KHz, 6.25%	475-01-00003	EMR	13754	1	1	
FILTER, 4PP, 128 KHz, 6.25%	475-01-00004	EMR	13754	1	1	
FILTER, 4PP, 256 KHz, 6.25%	475-01-00005	EMR	13754	1	1	
TRANSFORMER, Assy.	262-89-00008	EMR	6562-2	1	1	
INDUCTOR, .142 MH 1%	453-02-00141	EMR	7688-2	34	3	
INTEGRATED CIRCUIT	046-14-00002	SYL	SG-53-03	4	1	
INTEGRATED CIRCUIT	046-14-00003	SYL	SG-63-03	1	1	
INTEGRATED CIRCUIT	046-14-00006	SYL	SG-142-03	2	1	
INTEGRATED CIRCUIT	046-14-00007	SYL	SG-143-03	8	2	
INTEGRATED CIRCUIT	046-14-00009	SYL	SF-53-03	44	4	
INTEGRATED CIRCUIT, Diff./Cascode Amplifier	046-15-00002	RCA	CA3028A	2	1	
INTEGRATED CIRCUIT, AC Coupled J-K F/F	046-16-00002	MOT	MC358G/ SC1322A	16	3	
INTEGRATED CIRCUIT, Dual 2-Input NOR	046-16-00003	MOT/STEW WAR	MC360G/ SW360G	5	1	
INTEGRATED CIRCUIT, Bias Driver	046-16-00005	MOT	MC 354G	1	1	
INTEGRATED CIRCUIT, Differential Comparator	046-16-00013	MOT	MC1710CP or MC1710CL	1	1	
INTEGRATED CIRCUIT, Diff. Pair, Temp./Con.	046-18-00012	FCH	U5U7726323	1	1	
INTEGRATED CIRCUIT, Binary Counter/ Regulator, Mech.	046-97-00001	TI, SIG	SN7490N, N8280A	3	1	

Table 6-16 (Cont'd.). Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
INTEGRATED CIRCUIT, Operational Amplifier	046-97-00027	NSC	LM201H or LM301AH	1	1	
DIODE	088-10-07480	JEDEC	1N748	1	1	
DIODE, Ref., 9V/7.5MA, .005%	088-10-09360	MML 2A *	1N936	2	1	
DIODE, Ref., 11.7V/7.5MA, .00	088-10-09430	JEDEC	1N943	3	1	
DIODE, Rectifier, 100V, 1A, I	088-10-40020	JEDEC	1N4002	5	1	
DIODE, Sw., 75V/5UA, 4NS/10MA	088-10-41480	JEDEC	1N4148	362	17	
DIODE, Stabistor, .84-1.25V	088-10-48290	JEDEC	1N4829	2	1	
DIODE, Volt Var. Cap., 20V	088-16-00079	MOT	MV1642	1	1	
DIODE, 1N746A Zener, 3.3V	088-99-00099	EMR	642-00	4	1	
DIODE, 1N750A Zener, 4.7V	088-99-00109	EMR	642-04	1	1	
DIODE, 1N753A Zener, 6.2V	088-99-00329	EMR	642-07	1	1	
FUSE, 1 Amp. 250V	120-98-00012	LITTELFUSE	312001	2	10	
FUSE, Slo-Blo, 1-1/2 Amp	120-98-00022	LITTELFUSE	31301.5	1	10	
FUSE, Fast-Blo, 1-1/2 Amp	120-98-00033	LITTELFUSE	31201.5	1	10	
FUSE, Fast-Blo, 2 Amp	120-98-00034	LITTELFUSE	312002	1	10	
FUSE, Fast-Blo, 1-1/4 Amp	120-98-00039	LITTELFUSE	3121.25	1	10	
LAMP, T-1-3/4 28V, .04A	151-02-00001	G.E.	MS25237-327	1	1	
LIGHT, 28V, 40MA	155-98-00011	ELDEMA	CFW-22556-06	5	1	
POTENTIOMETER, 500 Ohms ±10%, 1W	201-98-00014	MML 27 *	3810P/910-20	3	1	
POTENTIOMETER, 1K ±10%, 1W	201-98-00015	MML 27 *	3810P/910-20	1	1	
POTENTIOMETER, 200 Ohms ±10%, 1W	201-98-00029	MML 27 *	3810P/910-20	1	1	
POTENTIOMETER, 50 Ohms ±30%, 1/2W	201-98-00068	BECKMAN	62PR50	1	1	
POTENTIOMETER, 1K ±5%, 10T, .030 Res.	201-98-00077	CLAROSTAT	CM35479	2	1	
POTENTIOMETER, 1K ±30%, 1/2W	201-98-00091	BECKMAN	62PR1K	1	1	
POTENTIOMETER, 2K ±30%, 1/2W	201-98-00092	BECKMAN	62PR2K	3	1	
POTENTIOMETER, 5K ±30%, 1/2W	201-98-00093	BECKMAN	62PR5K	2	1	

* EMR Multiple Manufacturers' List - Order part from EMR by description.

Table 6-16 (Cont'd.). Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
POTENTIOMETER, 20K ±10%, .75W	201-98-00105	BECKMAN	79PR20K	6	2	
POTENTIOMETER, 50K ±10%, .75W	201-98-00106	BECKMAN	79PR50K	1	1	
POTENTIOMETER, 50 Ohms ±10%, .75W	201-98-00121	BECKMAN	79PR50	3	1	
POTENTIOMETER, 500 Ohms ±10%, .75W	201-98-00122	BECKMAN	79PR500	3	1	
POTENTIOMETER, 100 Ohms +500 PPM,1T	201-98-00136	BECKMAN	62PR100	2	1	
POTENTIOMETER, 1K ±10%, .75W	201-98-00138	BECKMAN	79PR1K	1	1	
POTENTIOMETER, 100 Ohms ±10%, .75W	201-98-00145	BECKMAN	79PR100	10	2	
POTENTIOMETER, 20 Ohms ±30%, 1/2W	201-98-00146	BECKMAN	62PR20	4	1	
POTENTIOMETER, 5K ±10%, .75W	201-98-00147	BECKMAN	79PR5K	1	1	
POTENTIOMETER, 10K ±10%, .75W	201-98-00148	BECKMAN	79PR10K	2	1	
POTENTIOMETER, 10K ±30%, 1/2W	201-98-00149	BECKMAN	62PR10K	11	2	
POTENTIOMETER, 50 Ohms ±10%, 1W	201-98-00157	MML 27 *	3810P/910-20	2	1	
RECTIFIER	214-98-00001	MOT	MDA952-2	3	1	
RELAY, 2 Form A Contacts	219-98-00045	HATHAWAY INS	65630-37/GP-2A-26P	19	3	
RELAY, 2 Form C Contacts	219-98-00046	HATHAWAY INS	65627-8/GP-2C-26FCD	1	1	
RELAY, 4PST, NO, 26V	219-98-00050	HATHAWAY INS	65630-39/GP-4A-26P	6	2	
RELAY, SPDT, NO, 26V	219-98-00051	HATHAWAY INS	65627-7/GP-1C-26FCD	5	1	
RELAY, 1 Form A 125MA	219-98-00054	HATHAWAY INS	65630-36/GP-1A-26P	2	1	
RELAY, 2 Form A 12VA	219-98-00055	DOUG RAND	24MC-2A	5	1	
RELAY, 1 Form A 125MA	219-98-00065	HATHAWAY	65630-15/GP-1A-26D	8	2	
RELAY, 2 Form A Contacts	219-98-00066	HATHAWAY	65630-16/GP-2A-26D	22	3	
RELAY, SPST, NC, 26V	219-98-00068	HATHAWAY	65630-19/GP-1B-26D	4	1	

* EMR Multiple Manufacturers' List - Order part from EMR by description.

Table 6-16 (Cont'd.). Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
RELAY, DPST, NC, 26V	219-98-00069	HATHAWAY	65630-20/GP-2B-26D	4	1	
SWITCH, Pushbutton, Lited	250-98-00044	PENDAR	1160A7L56 W1-L	1	1	
TRANSISTOR, NPN Sw-Ampl, 5W, 40V	263-10-30530	JEDEC	2N3053	1	1	
TRANSISTOR, NPN Sw-Ampl, 60V, 1.8W	263-10-31160	JEDEC	2N3116	13	2	
TRANSISTOR, NPN 40V, 300MA Sw, On	263-10-36460	JEDEC	2N3646	10	2	
TRANSISTOR, PNP 60V, 4A Sw-Driver	263-10-37400	JEDEC	2N3740	4	1	
TRANSISTOR, NPN 60V, 4A Sw-Ampl	263-10-37660	JEDEC	2N3766	3	1	
TRANSISTOR, NPN 40V, Sw-Ampl, HFE	263-10-39470	JEDEC	2N3947	85	6	
TRANSISTOR, PNP 60V, 1A, HFE 15	263-10-40370	JEDEC	2N4037	1	1	
TRANSISTOR, Sw-Ampl 40V, 1A, 30W	263-10-49180	JEDEC	2N4918	1	1	
TRANSISTOR, Sw-Ampl 40V, 1A, 30W	263-10-49210	JEDEC	2N4921	3	1	
TRANSISTOR	263-16-00109	MOT	MJ480	3	1	
TRANSISTOR	263-16-00119	MOT	MJ490	2	1	
TRANSISTOR, PNP Dual 40V, LL Diff.	263-16-00129	MOT	MD3251	2	1	
TRANSISTOR, NPN, Dual Ampl	263-16-00179	MOT	MD8001	5	1	
TRANSISTOR, Dual NPN, DC to VHF	263-16-00209	MOT	MD2219	2	1	
TRANSISTOR, NPN Diff. Ampl, VCB 50	263-99-00089	EMR	666	5	1	
TRANSISTOR	263-99-00139	EMR	805-1	40	4	
CAPACITOR, .1 µf ±20%, 50V, LS.200	301-13-10002	ERIE	8131-050-651-104M	167	10	
CAPACITOR, .01 µf $^{-20\%}_{+80\%}$, 100V	301-71-10001	ERIE	805-000 X5VO 103Z	33	3	
CAPACITOR, 130 Pf ±1%, 500V	304-20-13009	EMR	600	44	4	
CAPACITOR, 2500 Pf ±1%, 500V	305-20-25000	EMR	600	7	1	
CAPACITOR, 5350 Pf ±1%	306-20-53500	EMR	600	1	1	
CAPACITOR, 1.0 µf ±20%, 35V	336-23-10003	EMR	601	69	6	
RESISTOR, 1K ±1%, 1/8W	605-09-10000	EMR	625	15	2	
RESISTOR, 10.0K ±1%, 1/8W	605-09-10001	EMR	625	15	2	
RESISTOR, 301K ±1%, 1/8W	605-09-30102	EMR	625	10	2	

Table 6-16 (Cont'd.). Model 4145-01 Recommended Spares List

PART DESCRIPTION	EMR STOCK NO.	VENDOR NAME	VENDOR PART NO.	TQ	RS	PRICE
RESISTOR, 10 Ohms ±5%, 1/4W	616-02-01009	ALLEN BRAD	RC07GF100J	91	7	
RESISTOR, 33 Ohms ±5%, 1/4W	616-02-03309	ALLEN BRAD	RC07GF330J	12	2	
RESISTOR, 47 Ohms ±5%, 1/4W	616-02-04709	ALLEN BRAD	RC07GF470J	32	3	
RESISTOR, 51 Ohms ±5%, 1/4W	616-02-05109	ALLEN BRAD	RC07GF510J	16	2	
RESISTOR, 100 Ohms ±5%, 1/4W	616-02-10009	ALLEN BRAD	RC07GF101J	71	7	
RESISTOR, 220 Ohms ±5%, 1/4W	616-02-22009	ALLEN BRAD	RC07GF221J	14	2	
RESISTOR, 330 Ohms ±5%, 1/4W	616-02-33009	ALLEN BRAD	RC07GF331J	13	2	
RESISTOR, 360 Ohms ±5%, 1/4W	616-02-36009	ALLEN BRAD	RC07GF361J	11	2	
RESISTOR, 470 Ohms ±5%, 1/4W	616-02-47009	ALLEN BRAD	RC07GF471J	18	2	
RESISTOR, 1K ±5%, 1/4W	616-02-10000	ALLEN BRAD	RC07GF102J	63	6	
RESISTOR, 1.8K ±5%, 1/4W	616-02-18000	ALLEN BRAD	RC07GF182J	33	3	
RESISTOR, 2.2K ±5%, 1/4W	616-02-22000	ALLEN BRAD	RC07GF222J	27	3	
RESISTOR, 2.7K ±5%, 1/4W	616-02-27000	ALLEN BRAD	RC07GF272J	29	3	
RESISTOR, 4.7K ±5%, 1/4W	616-02-47000	ALLEN BRAD	RC07GF472J	24	3	
RESISTOR, 10K ±5%, 1/4W	616-02-10001	ALLEN BRAD	RC07GF103J	24	3	
RESISTOR, 12K ±5%, 1/4W	616-02-12001	ALLEN BRAD	RC07GF123J	12	2	
RESISTOR, 16K ±5%, 1/4W	616-02-16001	ALLEN BRAD	RC07GF163J	17	2	
RESISTOR, 18K ±5%, 1/4W	616-02-18001	ALLEN BRAD	RC07GF183J	25	3	
RESISTOR, 100K ±5%, 1/4W	616-02-10002	ALLEN BRAD	RC07GF104J	39	3	
CAPACITOR, 8200 Pf ±1%, 100V	721-41-82000	EMR	11-204	6	1	

MANUAL CHANGES

August, 1969

MANUAL CHANGE NOTICE #1

EFFECTIVITY: Model 4145; Harmonic Selector Card Assembly 15167, Serial Nos. 16 and Up.

DESCRIPTION: In Figure 5-10 and Table 6-4, components are changed to the following:

Q15 and Q16 -- Transistor, 263-16-00209, 04713, MD2219

December, 1969

MANUAL CHANGE NOTICE #2

EFFECTIVITY: Model 4145; Detector Card Schematic Diagram 17170.

DESCRIPTION: In Figure 5-24, note 4 changes to:

Bridge balance adjust 0-3.01K
RN60C's used.

May, 1970

MANUAL CHANGE NOTICE #3

EFFECTIVITY:

Model 4145, serial numbers 1 and up; VCO and Harmonic Mixer Card.

DESCRIPTION:

In Figure 5-11, component designations C30 and L14 are reversed.

September, 1970

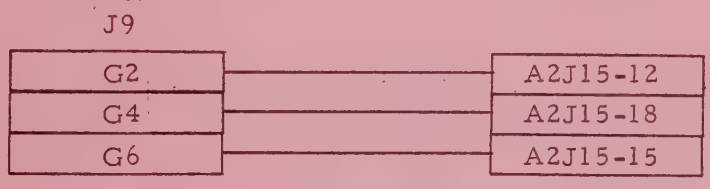
MANUAL CHANGE NOTICE #4

EFFECTIVITY: Model 4145 CBW Tunable Discriminator, serial numbers 20 and up.

DESCRIPTION: A rear panel connector, A3J9 (POWER SOURCE), is added to provide -18V DC and +20V DC power for use in the EMR Model 14747-1 Inverter Amplifier. When required for inverting the polarity of the tape-speed compensation input signal, the inverting amplifier is connected to TSC connector A3J2 on the rear panel of the Model 4145. The TSC input signal is applied to the input BNC connector on the amplifier and the power cord on the amplifier module is mated with rear panel connector A3J9.

CHANGE:

a. On Figure 5-31, add the following wiring data:



b. Under the parts breakdown for Rear Connector Panel Assy. A3 in Table 6-1 add J9 (Same as J5).

September, 1970

MANUAL CHANGE NOTICE #5

EFFECTIVITY: Model 4145, Input Level Adjust Card, serial numbers 43, and 51 and up.

DESCRIPTION: On Input Level Adjust Card, Assembly No. 15155-1, component values were changed as described below:

C12 -- CAPACITOR, .01 Mf $^{+80\%}_{-20\%}$, 100V; EMR STOCK NO. - 301-71-10001; MFGR. CODE - 72982; MFGR. PART NO. - 805-000 X5VO 103Z.

R33 -- RESISTOR, 15 Ohms ±5%, 1/4W; EMR STOCK NO. - 616-02-01509; MFGR. CODE - 01121; MFGR. PART NO. - RC07GF150J.

R71 -- RESISTOR, 1.43K ±1%, 1/8W; EMR STOCK NO. - 605-09-14300; MFGR. CODE - 06141; MFGR. PART NO. - 625.

Manual areas affected by the above changes are Figure 5-14 and Table 6-6. In addition, the following note is added to Figure 5-13:

R71, R108, and R109 may be changed by test.

September, 1970

MANUAL CHANGE NOTICE #6

EFFECTIVITY: Model 4145, Regulator and Output Amplifier Card (Assy. No. 14823-1), serial numbers 32, 52, 54, and 100 and up.

DESCRIPTION: In Figure 5-30 and Table 6-14, change the value of fuse F5 as follows:

F5 -- FUSE, Fast Blo, 2 Amp; EMR STOCK NO. - 120-98-00034; MFGR. CODE - 75915; MFGR. PART NO. - 312002.

May, 1975

MANUAL CHANGE NOTICE #7

EFFECTIVITY: Model 4145, Serial Numbers 80 and Up.

DESCRIPTION: (1) On First IF Card A2A9 schematic diagram (Figure 5-18) component values should be changed as follows:

R126 thru R135 -- 10 ohm ± 5%, 1/4W

(2) On Harmonic Selector Card A2A5 schematic diagram (Figure 5-10), the following listed component should be marked "not used:"

R148, C44, C45

Potentiometer R150 is changed from 50 ohm to 10K ohm.

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